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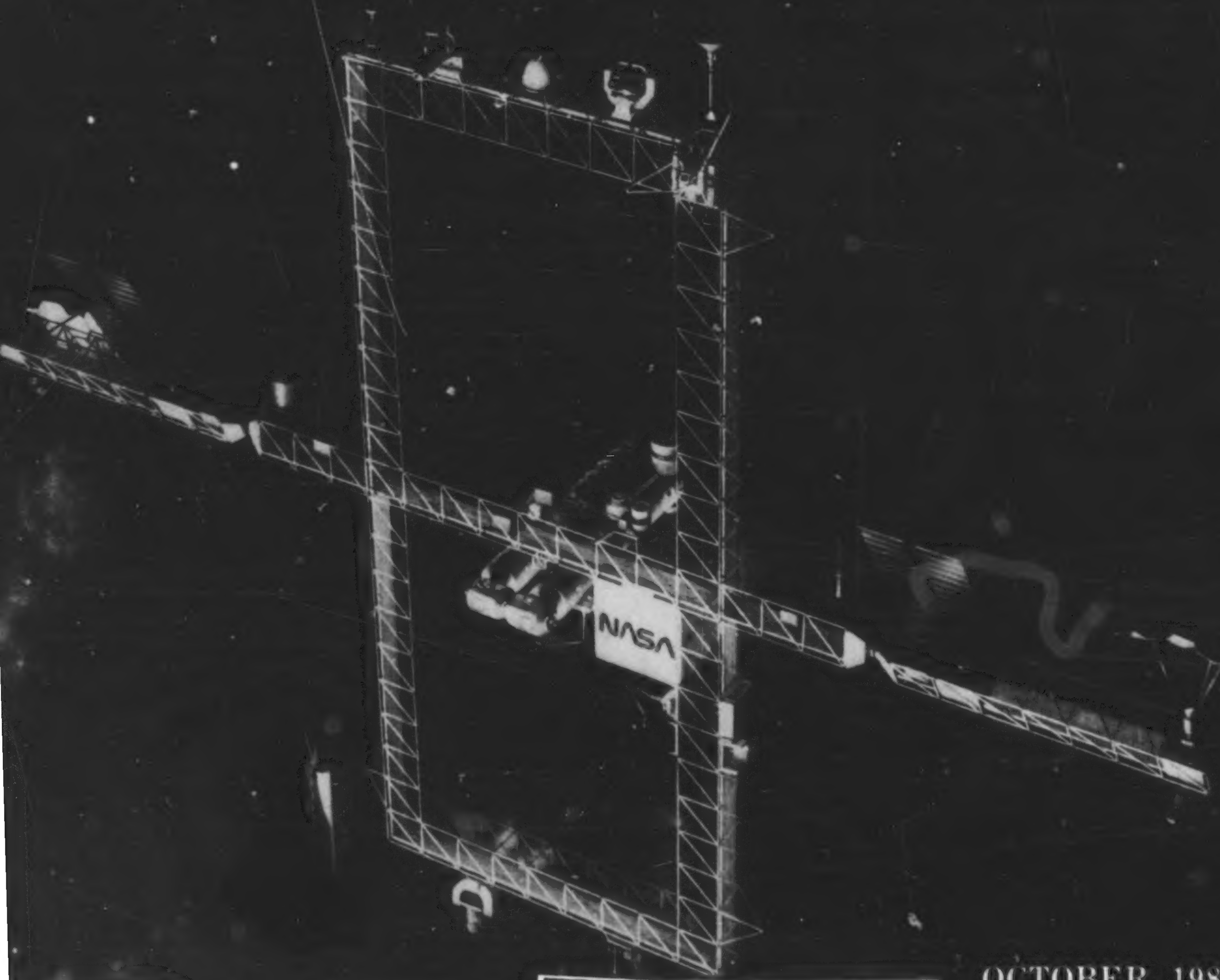
# SPACE STATION OPERATIONS TASK FORCE SUMMARY REPORT



OCTOBER, 1987

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1.2:

I have accepted this Space Station Operations Task Force (SSOTF) report as a reference point from which to implement the Program's concept for operations. It is clearly a thoughtful and extensive analysis of key Space Station Program parameters.

At this time, the Program has started the detailed work of preparing the necessary program documentation, the operations capability requirements, the instructions to contractors, the agreements with other organizations, and the refinement of the management tools required to effect the implementation.

The Space Station Program will carefully review all SSOTF recommendations. This review will involve all relevant NASA organizations. I anticipate that a large portion of the recommendations will be approved and implemented. However, because of the extensive number and the implications of the Task Force recommendations, it should be expected that not all will pass this final screening.

Andrew J. Stofan
Associate Administrator
for Space Station

NASA
National Aeronautics and
Space Administration

# SPACE STATION OPERATIONS TASK FORCE

## SUMMARY REPORT

OCTOBER, 1987

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# GRAPHICS LEGEND NOTE

To aid reader understanding of the various Figures, Tables and Sidebars found throughout this report, a combination of color tones and computer-generated crosshatch has been used as graphics background enhancement. The following colors and crosshatch pattern represent a family of operations functions, products, organizations, or facilities associated with a particular aspect of Space Station Operations and are consistent in their representation throughout the report:

| | |
|---|---|
| The Space Station User Community. . . . . . . . . . . | □ |
| Space Station Program Policy Level. . . . . . . . . . . | ■ |
| Space Station Program Integration Level. . . . . . . . . . | ▒ |
| Space Station Program Execution Level. . . . . . . . . . | □ |
| Interface with a NASA Organization<br>Other than the Space Station Operations Organization. . . . . . . . | ▨ |

Additional computer-generated shadings or symbols appear as required to uniquely support a particular figure or table and are self-explanatory.

# SPACE STATION OPERATIONS TASK FORCE
# SUMMARY REPORT

## ACKNOWLEDGMENTS

The Space Station Operations Task Force is indebted to hundreds of people who contributed time and effort to its task. Many of those individuals and organizations are acknowledged here and others are included in the individual SSOTF Panel reports. We are grateful to all who participated and extend our thanks to them.

## CONSULTING PARTICIPANTS:

A. Space Station Program Management: John Aaron, NASA JSC; David Bates, NASA JSC; Harold Benson, NASA JSC; David Black, NASA HQS; B. J. Bluth, NASA HQS; Tom Bonner, NASA JSC; Margaret Finarelli, NASA HQS; Terence Finn, NASA HQS; Dana Hall, NASA HQS; Charles Harlan, NASA JSC; Mary D. Kerwin, NASA HQS; Franklin Martin, NASA HQS; James Ragusa, NASA KSC; Eugene Rice, NASA JSC; Mary Jo Smith, NASA HQS; Andrew Stofan, NASA HQS; Giulio Varsi, NASA HQS; Wayne Whittington, NASA JSC.

B. United States Industry: Ball Aerospace, Dave Roalstad; Boeing, William Fedor, Gordon Hosmer; Computer Sciences Corporation, William Schneider; General Electric, U. R. Alvarado, Stephen Williams; IBM, J. Clint Hundley, Anthony J. Macina; Lockheed Missiles and Space Company, A. Gustafaro; McDonnell Douglas Astronautics, Peter Kurzhals, Steven Paddock; Pace & Waite, Robert Pace; Rockwell International, Don Farthing, Bob Bodica, Berend Koerber (MBB/ERNO); TRW, Ed Gibson; United Airlines, Tom Edwards, Neil A. Johnson; Wyle Laboratories, Ronald Giuntini, Karen Seiser.

C. Former NASA Managers: Leland Belew, Charles Mathews, William Schneider.

D. SESAC Task Force on Scientific Use of Space Station: Peter Banks, Chairman.

E. International Partners:

- Canada (National Research Council of Canada): Marc Garneau, Roy Van Koughnett, Parvez Kumar.
- Japan (National Space Development Agency): Seiji Higuchi, Chu Ishida, Nobuo Iwasaki, TakehikoKato, Katsuro Sakai, M. Saito.
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G. SSOTF Oversight Committee: Andrew Stofan, Chairman.

H. NASA Center Directors: Gen. Lew Allen, JPL; Aaron Cohen, JSC; Noel Hinners, GSFC; John Klineberg, LeRC; Gen. Forrest McCartney, KSC; Richard Petersen, LaRC; J. R. Thompson, MSFC.

I. United States Academia: John Hunsucker, University of Houston; Dr. David Criswell, University of California at San Diego.

**Task Force Contractor Support:**

Booz, Allen, & Hamilton, Bethesda, MD

- William E. Brooks
- James T. Kaidy
- Henry J. Pierce

CSP Associates, Cambridge, MA

- Mark R. Oderman
- Rebecca J. Simmons
- Marc E. Vaucher

TADCORPS, Washington, DC

- Pam Day
- Robert Haltermann
- Dennis Fielder
- Dr. William Lawbaugh

**Task Force Administrative Staff:**

- Wayne Richie - NASA HQS
- Leila Taylor - NASA KSC
- Vicki Thorne - NASA HQS
- Libby Wells - NASA KSC

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- Charles B. Mars - NASA KSC
- George Anikis - NASA HQS
- Granville Paules, III - NASA HQS

## ABBREVIATIONS AND ACRONYMS

The SSOTF Summary Report uses a number of abbreviations and acronyms. A glossary of these is presented here in order to facilitate the reader's comprehension of the text.

| | |
|---|---|
| AA | Associate Administrator (NASA) |
| ADD | Architectural Definition Document (SSIS) |
| AMPTE | Active Magnetospheric Particle Tracer Explorers |
| AO | Announcement of Opportunity |
| ASTP | Apollo Soyuz Test Program |
| AXAF | Advanced X-Ray Astrophysics Facility |
| CAI | Computer Aided Instruction |
| CAIT | Computer Aided Instructional Trainers |
| CCTV | Closed Circuit Television |
| CDR | Critical Design Review |
| CERV | Crew Emergency Rescue Vehicle |
| CETF | Critical Evaluation Task Force |
| COP | Co-Orbiting Platform |
| CUP | Consolidated Utilization Plan |
| DDT&E | Design, Development, Test, and Engineering/Evaluation |
| DMS | Data Management System |
| DOC | Discipline Operations Center |
| DOD | Department of Defense |
| ECLS | Environmental Control and Life Support |
| ELM | Experiment Logistics Module |
| ELV | Expendable Launch Vehicle |
| EM | Environmental Monitor |
| ESA | European Space Agency |
| ESC | Engineering Support Center |
| EVA | Extravehicular Activity |
| FAP | Flight Activity Plan |
| FDF | Flight Data File |
| FIM | Flight Integration Manager |
| FIP | Flight Increment Plan |
| FTS | Flight Telerobotic System |
| GFE | Government Furnished Equipment |
| GHz | Gigahertz |
| GN&C | Guidance, Navigation and Control |
| GOES | Geostationary Operational Environmental Satellite |
| GSFC | Goddard Space Flight Center |
| HEAO | High Energy Astronomy Observer |
| HMF | Health Maintenance Facility |
| HQS | Headquarters (NASA) |
| ICD | Interface Control Document |
| IHCP | Increment Hazard Control Plan |
| ILS | Integrated Logistics System |
| IMT | Increment Management Team |
| IOC | Initial Operational Capability |
| IOP | Increment Operations Plan |
| IOR | Increment Operations Review |
| ITM | Increment Transfer Manager |
| ITP | Increment Training Plan |
| ITVF | Integrated Test and Verification Facility |
| IUE | International Ultraviolet Explorer |
| IVA | Intravehicular Activity |
| IVE | Interface Verification Equipment |
| IWG | Investigators Working Group |
| JEM | Japanese Experiment Module |
| JPL | Jet Propulsion Laboratory |
| JSC | Johnson Space Center |
| KSC | Kennedy Space Center |
| LaRC | Langley Research Center |
| LDEF | Long Duration Exposure Facility |
| LeRC | Lewis Research Center |
| LOC | Logistics Operations Center |
| LSM | Logistics Support Manager |
| M&O | Maintenance and Operations |
| MBPS | Megabits per second |
| MCB | Multilateral Control Board |
| MCC | Mission Control Center |
| MDF | Manipulator Development Facility |
| MOU | Memorandum of Understanding |
| MRDB | Mission Requirements Data Base |
| MSC(S) | Mobile Servicing Center(System) |
| MSFC | Marshall Space Flight Center |
| NASCOM | NASA voice Communications network |
| NASDA | National Space Development Agency (Japan) |
| NCC | Network Control Center |
| NOAA | National Oceanic and Atmospheric Administration |
| OAST | Office of Aeronautics and Space Technology |
| OCP | Office of Commercial Programs |
| OEX | Orbiter Experiment (program) |
| OMS | Operations Management System |
| OMV | Orbital Maneuvering Vehicle |
| OPS | Operations |
| ORU | Orbital Replacement Unit |
| OSF | Office of Space Flight |
| OSSA | Office of Space Science and Applications |
| OSSO | Office of Space Station Operations |
| PAM | Payload Accommodation Manager |
| PHCP | Payload Hazard Control Plan |
| PIA | Payload Interface Adapter |
| PIM | Payload Integration Manager |
| PIP | Payload Integration Plan |
| PI | Principal Investigator |
| PIWG | Platform Investigator Working Group |
| POCB | Program Operations Control Board |
| POIC | Payload Operations Integration Center |
| POP | Platform Operations Plan |
| POP | Polar Orbiting Platform |
| PPOC | Platform Payload Operations Center |
| PPOP | Platform Payload Operations Plan |
| PS | Payload Scientist |
| PSC | Platform Support Center |
| PSCN | Program Support Communications Network |
| PSRB | Program Safety Review Board |
| PTIF | Payload Training Integration Facility |
| PTOC | Platform Transfer Operations Center |
| PTOP | Platform Transfer Operations Plan |
| RF | Radio Frequency |
| RFF | Request for Flight |
| RFP | Request for Proposal |
| ROC | Regional Operations Center |
| S&TC | Science and Technology Center |
| SCP | Systems Control Panel |
| SDF | Software Development Facility |
| SE&I | Systems Engineering and Integration |

| | |
|---|---|
| SE&IO | Systems Engineering and Integration Office |
| SEM | Sustaining Engineering Manager |
| SESAC | Space and Earth Sciences Advisory Committee |
| SHCP | System Hazard Control Plan |
| SIRTF | Space Infra-Red Telescope Facility |
| SLC | Shuttle Launch Complex |
| SO | Station Operator |
| SOP | Systems Operations Panel |
| SPOT | Station Proximity Operations Trainer |
| SRM&QA | Safety, Reliability, Maintainability and Quality Assurance |
| SS | Space Station |
| SS | Station Scientist |
| SSE | Software Support Environment |
| SSIS | Space Station Information System |
| SSOTF | Space Station Operations Task Force |
| SSP | Space Station Program |
| SSPF | Space Station Processing Facility |
| SSSC | Space Station Support Center |
| SSSEO | Space Station Sustaining Engineering Office |
| SSST | Space Station Systems Trainer |
| SSTCB | Space Station Training Control Board |
| SSTF | Space Station Training Facility |
| SSUB | Space Station User Board |
| SSUWG | Space Station Users Working Group |
| STA | Science and Technology Agency (Japan) |
| STDN | Space Tracking and Data Acquisition Network |
| STS | Space Transportation System |
| TDRS | Tracking and Data Relay Satellite |
| TDRSS | Tracking and Data Relay Satellite System |
| TFSUSS | Task Force on Scientific Use of Space Station |
| TMIS | Technical and Management Information System |
| TOP | Tactical Operations Plan |
| TV | Television |
| UAIO | User Accommodation Integration Office. |
| UCP | Utilization Control Panel |
| UODD | Utilization and Operations Development Division |
| UOF | User Operations Facility |
| UOIO | Utilization and Operations Integration Office |
| UOP | Utilization Operations Panel |
| VAFB | Vandenburg Air Force Base |
| WETF | Weightless Environment Training Facility |

## DEFINITION OF KEY SSOTF TERMS

This Summary Report uses a standard set of terms established by the Task Force as a basis for developing the description of the proposed operations framework for the Space Station Program. These terms and definitions will become evident as the reader reviews this document. However, due to the number of organizations and professional disciplines represented by the SSOTF's various participants, the terms may be used differently than the reader is normally acquainted with. Hence, a definition of key terms used by the Task Force follows as an aid to the reader in understanding the text. A more comprehensive Lexicon is included as Appendix D of this report.

- **Space Station Program, Space Station, Station Program, the Program and Station:** These terms are used synonymously and should always be interpreted as global in nature, each encompassing all of the component parts of the Program, manned and unmanned, both in space and on the ground.

- **Space Station Operations:** This term refers to all of the ground and space based activities required to operate all components of the Program, up to and including the operational interfaces with the user community.

- **Program Phase Definitions:** The Station Program is composed of two major phases of operations: development (encompassing system design, assembly, and operational verification); and mature operations (encompassing system utilization and evolution). These two phases naturally overlap due to the progressive build-up of orbital capability and are more specifically defined as follows:

  1. **Station Development Phase:** This term applies to the period of time commencing with the Program management approval to develop and deploy the baselined Space Station elements. It is characterized by several overlapping sub-phases including: "operating system" requirements definition; design; implementation (construction); integration; acceptance testing; product delivery (including on-orbit assembly of Station elements); and product verification (on-orbit test and checkout). The Station "operating system" is defined to include the total complement of hardware, software, and personnel support capabilities (ground and on-orbit) required to proceed through the various sub-phases.

  2. **Station Mature Operations Phase:** Defined as the period of time commencing with the completion of assembly and on-orbit verification of a complement of Station elements sufficient to sustain a permanent manned presence in orbit. It includes the capability to routinely schedule useful payload operations activities among any remaining Station assembly tasks. Mature Operations are gradually phased-in as additional Station components are assembled and a full operational capability is achieved. It is also characterized by continuing plans for Station evolution and encompasses the subsequent growth or upgrade of Station systems and available resources.

- **The Manned Base:** This comprises all the partner-supplied manned elements of the Program composed of the core laboratory and habitation modules and their supporting structures (nodes, truss, and STS docking facilities).

- **Station Platforms:** These comprise the unmanned elements of the Program, and include one platform that co-orbits with the manned base (Co-Orbiting Platform - COP) supplied by the U.S.; and two platforms in polar orbit (Polar Orbiting Platforms -

POP); one to be supplied by NASA and the other by ESA. Together the manned base and platforms form the operational space components of the Program.

- **Station Users:** This term is global in scope encompassing all varieties of potential users of the various Station elements. The SSOTF assumed that user operations would be carefully coordinated and integrated into overall Station operations, and supported by all levels of the Program. However, the majority of user activities (such as payload selection, definition, development and, in some cases, payload-to-rack or PIA integration) would not fall under the direct management of the Space Station operations organization but would be conducted by the users themselves.

- **Space Operations:** This term includes all the operational components of the Program which provide the planning, training, and operational management for the conduct of on-orbit activities, up to and including the interfaces with the users. On-orbit vehicle systems operations, network data systems, and supporting ground operations are included here.

- **Ground Operations:** This term includes all components of the Program which provide the planning, engineering, and operational management for the conduct of integrated logistics support, up to and including the interfaces with the users. Logistics, sustaining engineering, pre/post-flight processing, and transportation services operations are included here.

- **Increment Operations:** An increment is defined as the period of time between STS visits to the manned base or between STS (or Station-based) OMV servicing visits to a platform. For platforms, the term increment may also be used to describe the platform's mission duration or, if a single mission platform, its operational lifetime.

  A specific increment's planning operation may begin several years before the relevant STS launch (or OMV deployment from the manned base). A specific increment's execution operations begin with the Station Program's real-time support to launch of the relevant transportation mission (STS/OMV), and generally extends through the initiation of similar support to the respective follow-on transportation mission. ELV arrivals at Station elements are contained within the relevant increment.

  For the manned base, increment duration may vary according to the number of STS visits per year (for eight flights per year, increment duration is 45 days; for five flights per year, 72 days). For platforms, increment duration is related to the period between servicing, between deployment and return to earth, or between deployment and the end of its operational lifetime.

- **Transfer Operations:** These are activities related to preparing for and conducting resupply, maintenance and servicing visits to the manned base and platforms. Transfer operations are a normal part of the increment planning and execution process. Transfer operations encompass preparing for arrival of an STS at the manned base, or an STS, ELV or OMV at a platform (new or previously deployed), and the subsequent "transfer" of crew and/or equipment as a part of logistics resupply, maintenance or servicing, or initial platform deployment. Transfer operations also encompass the stowage and return of payload equipment, trash and experiment samples/products.

- **Maintenance Activities:** The task of keeping Station systems and hardware within specified performance limits. The term maintenance applies specifically to Station systems and structure, not to user payloads. Functions such as equipment repair, replacement, recalibration and cleaning are typical of Station systems maintenance requirements. These same functions, when performed on user systems, are referred to as servicing.

- **Servicing Activities:** The Station task of keeping user payloads and hardware in operating condition, or returning to operating condition. Functions such as equipment repair, replacement, recalibration and cleaning are typical of user systems servicing requirements. These same functions, when performed on Station systems, are referred to as maintenance.

- **Organizational Definitions:** The SSOTF has suggested an organizational structure for implementing its proposed framework for operations. This has been defined as evolving through two stages: transition and mature operations. These organizations are defined as follows:

  1. **Transition Operations Organization:** The operations organization recommended by the SSOTF to be immediately established to support the Development Phase of the Program. Organizational emphasis will be placed on establishing clearly defined responsibilities to support development of an overall user accommodations and space systems operations capability supporting the systems design, operations planning, assembly, on-orbit verification, and early utilization periods within the Development Phase.

  2. **Mature Operations Organization:** The operations organization recommended by the SSOTF to be established in time to support the preparation and management of the Mature Operations Phase (beginning with the completion of on-orbit verification of the final element of the permanently manned Station). Organizational emphasis is placed on establishing clearly defined responsibilities for performing the routine planning and execution functions associated with Station utilization and systems operations over the lifetime of the Program. Provision is also made to support planning and integration of evolutionary Station systems and operational upgrades as the baselined Station configuration grows.

# PREFACE: SSOTF MANDATE AND HISTORY

## CHARTER AND GOALS

The Space Station Operations Task Force (SSOTF) was created by the NASA Office of Space Station to ensure that operations are given due consideration in Space Station planning efforts. Specifically, the SSOTF was asked to produce an operations framework which meets the Program objectives of safe and user-friendly operations, supports participation of Canada, the European Space Agency, and Japan in the operation of the Station, and gives due consideration to the long term issues of systems and user operations costs, evolutionary goals, maintaining NASA's technology base, and furthering science and development.

Dr. Peter Lyman of the Jet Propulsion Laboratory and Carl Shelley of Johnson Space Center were selected as co-chairmen for the SSOTF in September, 1986. The co-chairmen recruited staff for the SSOTF from a broad spectrum of NASA expertise. Special effort was made to solicit membership from both within and outside the Office of Space Station to provide a balanced knowledge base on how to conduct operations. All Field Centers and NASA Code organizations were represented, and the program experience of the combined membership drew from NASA's entire program history. (See Table i-1.)

The charter of the SSOTF included the determination of functional operations requirements for the program; evaluating alternatives for satisfying identified requirements; and development of a Recommended Framework for Program operations.[1] The SSOTF was asked to identify roles and missions for NASA and its partners and to define Program and user interfaces. It was also asked to consider the Phase B design concepts, and to recommend any changes which would enhance operations and utilization.[2] Finally, the SSOTF was asked to provide sufficient detail for subsequent in-depth cost analysis exercises, and to incorporate preliminary assessments of operations costs in framework "tradeoff studies."[3]

The SSOTF charter did not cover a range of policy-level issues which also could impact Station operations. Such issues included providing a Program rationale (or "mission statement") for the Station, defining a prescribed evolutionary path (i.e., deciding along what functional lines the Station should evolve), or developing detailed cost estimates for the Recommended Framework. Other issues which extended beyond the SSOTF charter included assessing the adequacy of the STS support capability to implement Station operations, and providing a plan to accommodate the unique requirements of secure DOD operations. These issues need further definition by the Program in order to clarify their potential impact on overall Station operations.

## METHODOLOGY AND PRODUCTS

The Task Force began with an extensive series of briefings from space systems developers, operators, managers and users. The Space Station Program Office and Phase B Contractors furnished the Task Force with an in-depth review of current Program status with regard to both design and operations. The Task Force also met with managers and contractors from past and present NASA programs, as well as Associate Administrators and Center Directors who provided the Task Force with the benefit of their operations and contracting experience. In addition, the Task Force was briefed by a wide range of potential users, including a full spectrum from outside NASA (academic, commercial, and other government agencies).

The SSOTF methodology is depicted in Figure i-1. The SSOTF used the background briefings and materials as a baseline for defining a set of operations functions and evaluation criteria. Operations functions comprise the set of requirements which any Space Station operations framework must perform to meet Program objectives. Functions were broken down into smaller "subfunctions" until end-to-end functional flows could be described. The evaluation criteria were developed and used as a means of selecting among possible framework options and for relating operations concepts to achievement of Program goals.

The Task Force was composed of four panels which were divided along functional lines. (See Figure i-2.) Within each panel, concepts were proposed, refined, and evaluated in terms of their ability to meet functional requirements and overall Program goals. The four panels were: (1) Space Operations and Support Systems; (2) Ground Operations and Support Systems; (3) User Development and Integration; and (4) Management Integration. Space Operations incorporated all operational components of the Program which provide the planning, training, and operational management for the conduct of on-orbit activities. Ground Operations encompassed all components of the Program which provide the planning, engineering and operational management for the conduct of integrated logistics support. User Development encompassed all areas of the Program

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*[1] The SSOTF was directed to focus on the mature operations phase of the Space Station, but to ensure that the recommended framework accommodates special requirements generated during the development phase through mature operations, and later on to support evolutionary growth activities.*

*[2] In addition, the Task Force was directed to provide the Office of Space Station with a written response to the Phase C draft RFPs, to ensure that SSOTF concerns were incorporated into them to the fullest degree possible.*

*[3] SSOTF comments were incorporated in the Cost Commitment Team presentation to the NASA Deputy Administrator. One of the SSOTF's major recommendations is the development of detailed cost estimates for the Recommended Framework by the responsible Field Centers.*

AMPTE
APOLLO
ASTP
ATLAS
BUMPER-V2
CENTAUR
DEEP SPACE NETWORK
GEMINI
GOES
HEAO
HITCHHIKER
IUE
JUPITER/JUNO
KIWI
LACROSSE
LANDSAT/ERTS
LDEF
LUNAR ORBITER
MARINER
MERCURY
MINUTEMAN
NASCOM
NIMBUS
OEX
PATHFINDER
PEGASUS
PERSHING
POLARIS
REDSTONE
SATURN I/IB
SATURN V
SCOUT
SEASAT
SKYLAB
SOLAR MAX MISSION
SPACELAB
SPACE TELESCOPE (HST)
SPARTAN
STS
TARTER/TERRIER
TDRSS
THOR/DELTA
TIROS
TITAN I/II/III
TRIDENT
VANGUARD
VIKING
VOYAGER

Table i-1 SSOTF Program Experience

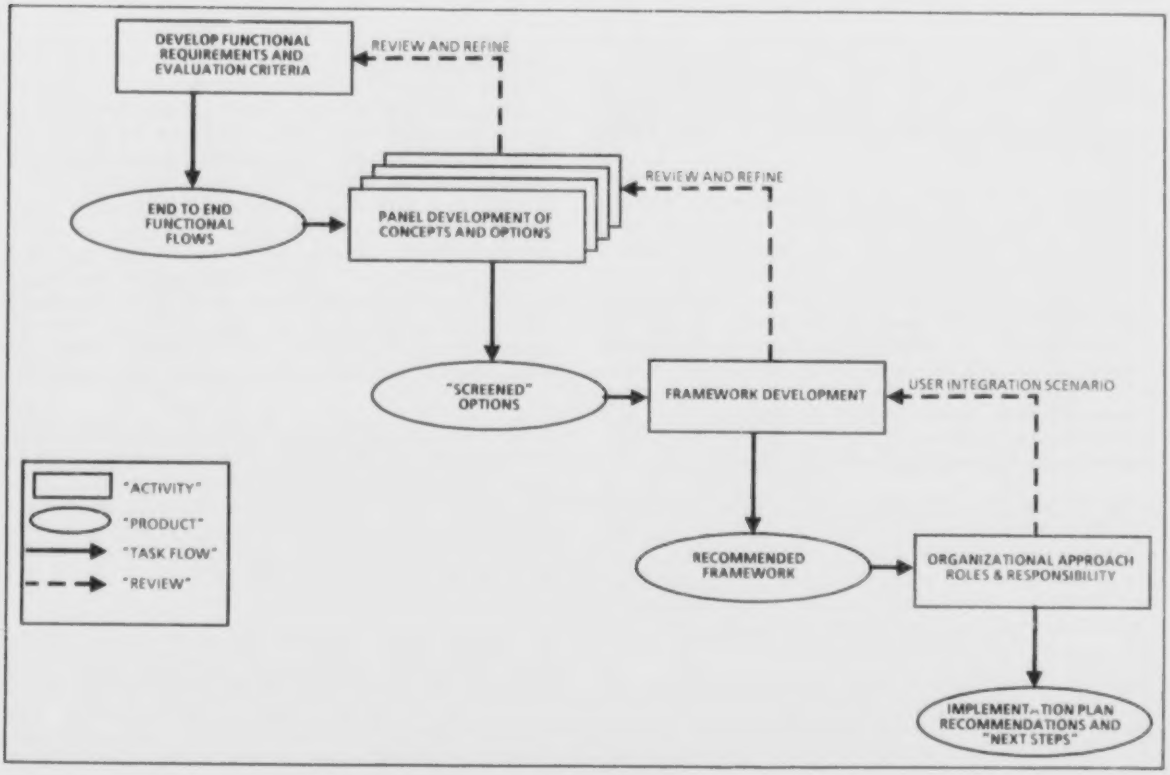
DEVELOP FUNCTIONAL REQUIREMENTS AND EVALUATION CRITERIA
REVIEW AND REFINE
END TO END FUNCTIONAL FLOWS
PANEL DEVELOPMENT OF CONCEPTS AND OPTIONS
REVIEW AND REFINE
"SCREENED" OPTIONS
FRAMEWORK DEVELOPMENT
USER INTEGRATION SCENARIO
"ACTIVITY"
"PRODUCT"
"TASK FLOW"
"REVIEW"
RECOMMENDED FRAMEWORK
ORGANIZATIONAL APPROACH ROLES & RESPONSIBILITY
IMPLEMENTATION PLAN RECOMMENDATIONS AND "NEXT STEPS"

Figure i-1 SSOTF Methodology

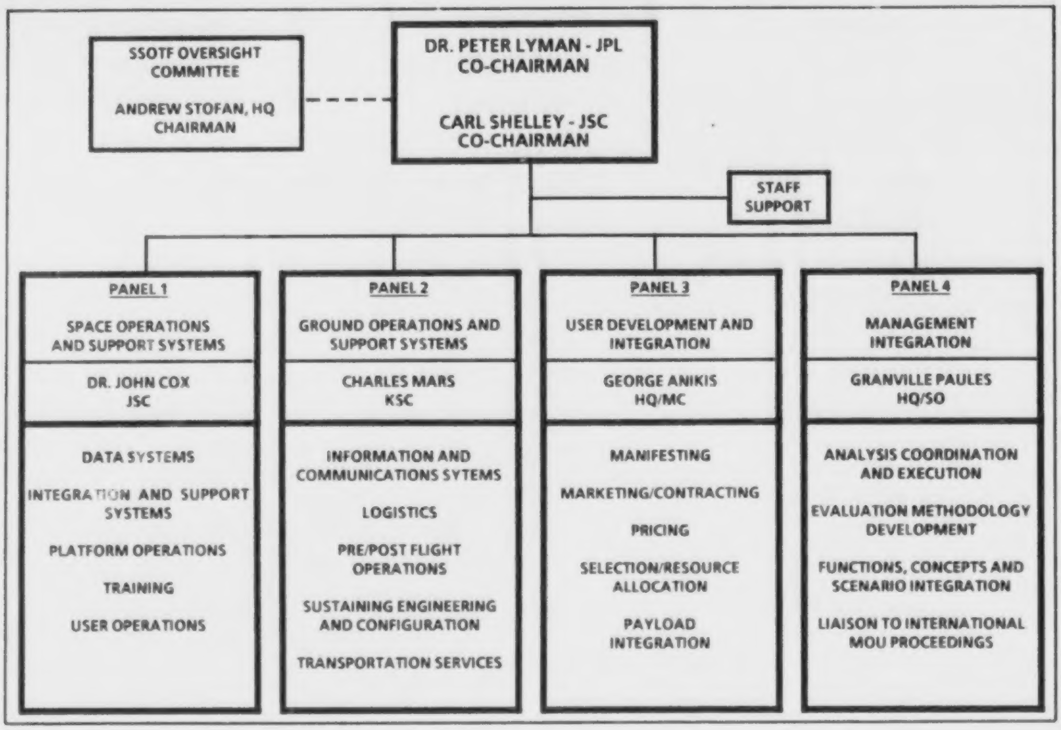
SSOTF OVERSIGHT COMMITTEE
ANDREW STOFAN, HQ CHAIRMAN
DR. PETER LYMAN - JPL CO-CHAIRMAN
CARL SHELLEY - JSC CO-CHAIRMAN
STAFF SUPPORT
PANEL 1
SPACE OPERATIONS AND SUPPORT SYSTEMS
DR. JOHN COX JSC
DATA SYSTEMS
INTEGRATION AND SUPPORT SYSTEMS
PLATFORM OPERATIONS
TRAINING
USER OPERATIONS
PANEL 2
GROUND OPERATIONS AND SUPPORT SYSTEMS
CHARLES MARS KSC
INFORMATION AND COMMUNICATIONS SYTEMS
LOGISTICS
PRE/POST FLIGHT OPERATIONS
SUSTAINING ENGINEERING AND CONFIGURATION
TRANSPORTATION SERVICES
PANEL 3
USER DEVELOPMENT AND INTEGRATION
GEORGE ANIKIS HQ/MC
MANIFESTING
MARKETING/CONTRACTING
PRICING
SELECTION/RESOURCE ALLOCATION
PAYLOAD INTEGRATION
PANEL 4
MANAGEMENT INTEGRATION
GRANVILLE PAULES HQ/SO
ANALYSIS COORDINATION AND EXECUTION
EVALUATION METHODOLOGY DEVELOPMENT
FUNCTIONS, CONCEPTS AND SCENARIO INTEGRATION
LIAISON TO INTERNATIONAL MOU PROCEEDINGS

Figure i-2 SSOTF Organization

related to user accommodation and integration activities. Management Integration included all SSOTF internal concept integration and analysis coordination required to provide an integrated operations framework.

After the panels had selected recommended options, the Task Force integrated them into a Recommended Framework which addressed the entire Space Station operations environment. The Recommended Framework was used to develop a prototype organization for managing the Program. Roles and responsibilities were developed and assigned to users, international partners, and NASA Headquarters and Field Center organizations. A "User Integration Scenario" was then drafted to ensure that the Recommended Framework would support "real-life" operations and to test the flexibility of the framework.

After drafting the Recommended Framework, the SSOTF compared its internally generated baseline against the current Space Station Program design and operations concepts. Where shortfalls were identified, the SSOTF recommended changes to the baseline or identified areas where further study is warranted.

This Summary Report, and associated Executive Summary, are the final integrated output of the SSOTF. (Detailed User Integration Flows for the Manned Base and Platforms are presented as supplements to the Summary Report.) In addition, each of the four panels has produced an in-depth report on its specific area of analysis.

## TASK FORCE SCHEDULE

In September and October 1986, the Task Force defined its tasks and allocated them among the four panels. From October through February, the panels developed their framework options and conducted preliminary evaluations. During March and April, each panel presented its findings to the Task Force, and revised its report drafts to incorporate changes and utilize a common lexicon. A "Panel 0", comprised of the SSOTF co-chairmen and the panel chairmen met during March and April to integrate the panel efforts into the Recommended Framework. In a parallel effort, the panels worked through the User Integration Scenario.

Briefings to outside parties occurred at several points. (See Figure i-3.) Representatives from ESA, Canada and Japan were briefed in November-December 1986, and again in mid-February. Partner representatives also had access to SSOTF draft papers and materials throughout the effort. A final presentation to the Partners was made on April 22, 1987.

The Task Force briefed the SSOTF Oversight Committee four times, and received additional guidance for options development and evaluation. Interim briefings were given in November and December 1986, and January 1987; a final briefing was given in April 1987. Associate Administrator for Space Station Andrew Stofan was given a final briefing in late April. The co-chairmen briefed NASA Administrator James Fletcher on May 15, 1987.

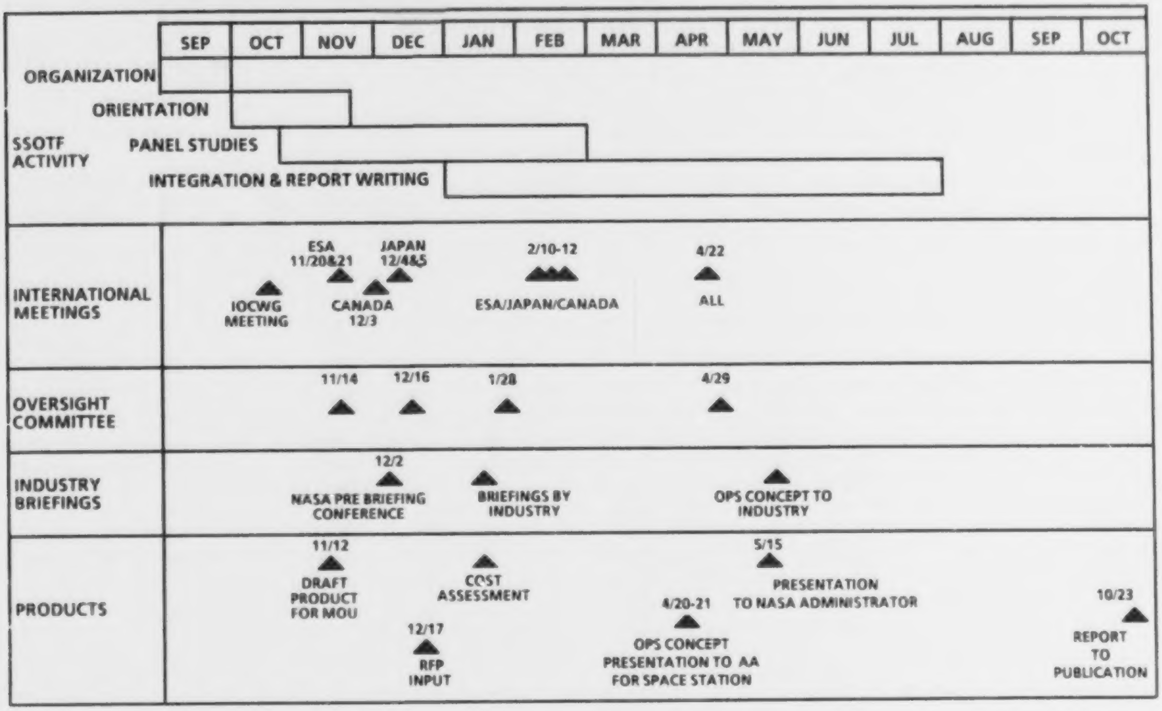

Figure i-3 SSOTF Schedule

Throughout the effort, informal briefings were held at the NASA Headquarters Office of Space Station, the NASA Field Centers, the various NASA "user codes" (i.e., Office of Aeronautics and Space Technology, Office of Commercial Programs and Office of Space Science and Applications), and with the Office of Space Flight. The Task Force framework was also reviewed by the Office of Safety, Reliability Maintainability and Quality Assurance in April. These formal and informal briefings were used as sources of critique and advice, but did not constrain the Task Force's recommendations.

# I. SUMMARY OF THE SSOTF OPERATIONS FRAMEWORK

## I.A. OVERVIEW

The SSOTF was chartered to produce an operations framework for the Space Station Program consisting of: (1) a definition of operations functions; (2) the development of an end-to-end planning and execution process; and (3) definition of roles and responsibilities for the proposed NASA operations organization during both the Development and Mature Operations Phases of the Program.

The SSOTF Framework is designed to ensure manageable and safe operations that promote the basic goal of productive and flexible operations for the Station's user community. Likewise, the Framework provides for top-to-bottom participation in the operations organization by NASA's international partners (Canada, the European Space Agency, and Japan). The Framework is flexible enough to facilitate evolution in the Program, both in terms of its physical configuration and in its usage. Operations cost considerations were incorporated; however, achievement of the Program's utilization goals was the driving factor in defining the Framework.

The SSOTF recommends separate, though similar, operations frameworks for the manned base and platforms. The primary feature of the manned base framework is a centralized operations planning and integration capability. For international activities, this means that operations and utilization planning are managed by NASA across the Program, with international personnel working in the NASA-led operations management organization. The international partners will support their contributions through the provision of user accommodation and engineering analysis facilities at partner sites.

User planning activities are led by the user community. U.S. user planning can be conducted on a geographic or disciplinary basis. User requirements are collated on a national basis by Space Station User Boards and "fused" at the Program Policy (Strategic Planning) level by a Multilateral Control Board chaired by NASA and staffed by NASA and its partners. At more detailed levels of planning, user activities are conducted by user working groups and supported by Station accommodation offices, while at the real-time operations level user activities are coordinated by a payload operations integration organization.

On orbit, an integrated international crew performs on a functional/skill basis, rather than as "element experts." The crew will be composed of both career (SSP) and non-career astronauts. On the ground, real-time operations of space systems are centralized within a single control facility. User operations integration activities (as opposed to user operations) for the current increment are also performed by a single facility. Logistics operations support personnel will perform integrated logistics support and prelaunch/postlanding processing of flight hardware at dedicated launch site facilities. Station users may integrate their payloads into internal flight racks or onto external truss adapters at distributed Science and Technology centers prior to delivery to the launch site for final acceptance and launch.

The SSOTF recommends that the unmanned platforms be operated by the contributing partner and separate from the manned base to provide maximum flexibility in user operations. Strategic utilization planning will be coordinated with the manned base, but tactical and execution level activities will be largely independent, except for the servicing and maintenance of co-orbiting platforms at the manned base. Platform operations will be managed in a manner similar to current unmanned satellite programs, with extensive support for user telescience operations.

## I.B. OPERATIONS FUNCTIONS

An operations function is a task or set of tasks required to sustain space operations.[1] The Task Force consensus was that the Space Station Program did not involve any completely new operations functions other than regularly scheduled resupply and changeout of user payloads. While Space Station is complex (both in "quantitative" terms relating to its size, and "qualitative" terms relating to its multiple uses), previous NASA missions have already mapped out similar operations functions. What is different is how NASA and its partners must organize to perform those functions, and the greater degree of flexibility which the operations framework must incorporate to meet its diverse and changing day-to-day tasks. Likewise, the Program's operations framework must embody a life cycle cost orientation consistent with its long mission.

Space Station operations functions can be defined in terms of categories of activity (related subfunctions). These categories are presented in Figure I-1. They fall naturally into three areas: Operations Oversight, Program Operations and User Operations. The Safety, Reliability Maintainability and Quality Assurance (SRM&QA) function is interwoven in both user and systems operations.

### Operations Oversight

NASA and its partners will need to establish, monitor and revise overall Program policies as required for Space Station operations. Many of these activities, such as budget planning and program performance and cost assessments, will be continuous in nature. Others,

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[1] *This definition separates activities involved in design, development, test and engineering (DDT&E) from operations. Phase C development efforts are not operations functions. However, the dividing line between DDT&E and operations can be very fine. For example, while building an additional module for the manned base would not be an operations function, activities associated with defining the requirements for the new module, approving its inclusion in the Program, engineering and operations assessments of the impact of the new module on the existing configuration, and manifesting and launch and integration of the new module, would be operations functions.*

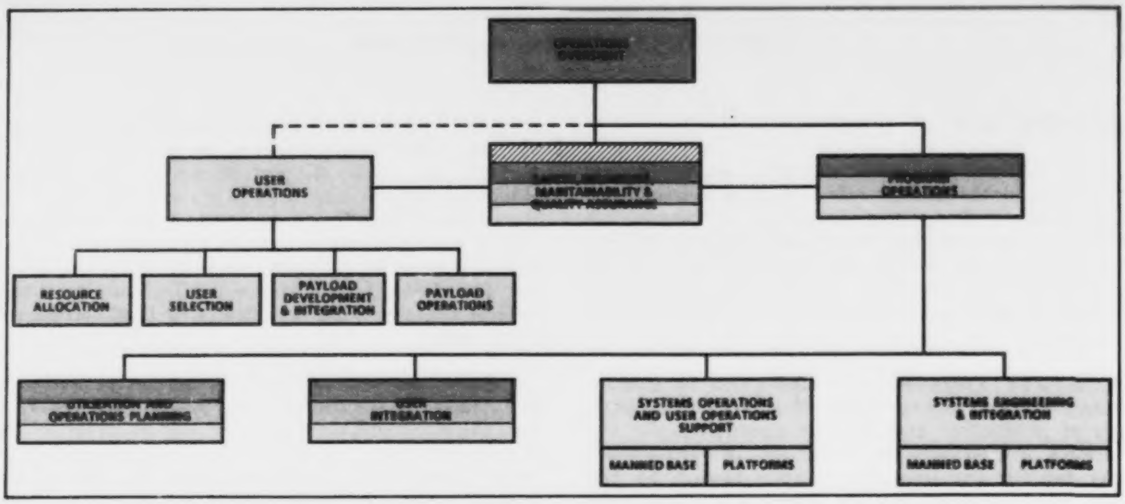

Figure I-1 Operations Functions

such as specific international negotiations or evolution planning will be "requirement-driven" and occur on a less frequent basis. These functions apply to the broad conduct of both user and SSP operations, and hence serve as the strategic frame within which all activities occur.

### User Operations

User Operations are those activities which are conducted by the user community. These can be broken into four subcategories: Resource Allocation; User Selection; Payload Development and Integration; and Payload Operations. These categories have a temporal relationship for an individual user: from the announcement of a flight opportunity to the performance of an experiment. From the Program perspective, all of the functions will be performed concurrently, as multiple users "work their way through the system."

### Program Operations

Space Station Program Operations are those activities which the SSP must perform to ensure that the Station elements are operated and maintained in a safe manner, and to support utilization of the Station resources by users. These fall into four subcategories: Utilization and Operations Planning; User Integration; System Operations and User Operations Support; and Systems Engineering and Integration.[2]

## I.C. OPERATIONS CONTROL AND PLANNING HIERARCHY

The SSOTF further detailed the operations functions presented in Figure I-1, and then hierarchically grouped the resultant subfunctions into three basic levels of management and control: Program Policy ("strategic"), Program Integration ("tactical") and Program Execution (real-time operations).[3] This management hierarchy exercises control over four levels of planning, each of which has one or more major planning products associated with it. The four planning levels are: Strategic Utilization and Operations Planning (five-year planning horizon); Tactical Utilization and Operations Planning (two-year planning horizon); Increment Planning (development of detailed planning and scheduling data for an increment specific time frame); and Increment Execute Planning (development of execute level plans and procedures to perform increment operations in real-time). The Program Integration (tactical) level of management controls both the Tactical Utilization and Operations Planning and Increment Planning functions. This hierarchy, and the major planning products associated with each management level are presented in Figure I-2.

### Strategic Utilization and Operations Planning

At the strategic level (defined as a planning horizon of five years), utilization planning is performed by each partner in accordance with allocations of resources as defined by international Memoranda of Understanding (MOUs). In the U.S., this will be done by a Space

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[2] *Detailed descriptions of these functions are presented in Section II.A.*

[3] *Many times, a single function (such as utilization and operations planning), will extend through all levels of management, while other functions (such as systems operations and user operations support) are generally associated with a single management level (Program Execution in this case). Hence, many functions will be performed simultaneously at multiple levels of management, and in multiple organizations within a single level of management. A complete regrouping of operations functions by level of management responsibility is presented in Appendix B of this report.*

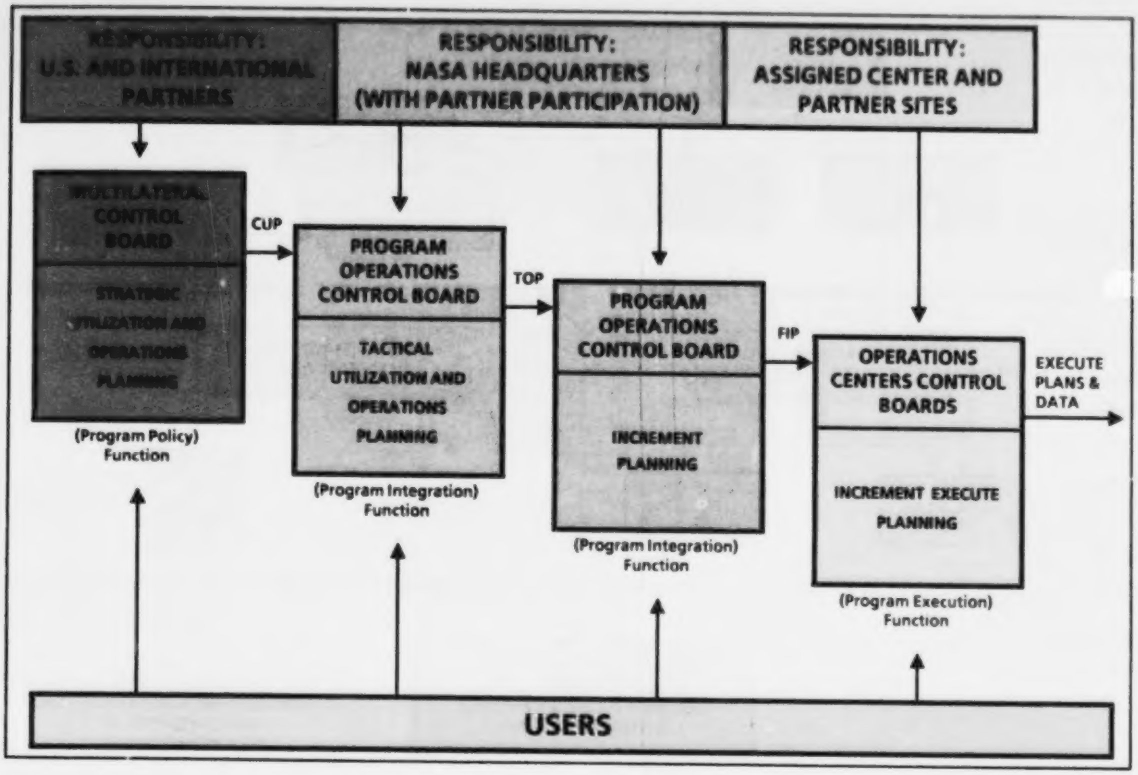
RESPONSIBILITY:
U.S. AND INTERNATIONAL PARTNERS
RESPONSIBILITY:
NASA HEADQUARTERS (WITH PARTNER PARTICIPATION)
RESPONSIBILITY:
ASSIGNED CENTER AND PARTNER SITES
MULTILATERAL CONTROL BOARD
STRATEGIC UTILIZATION AND OPERATIONS PLANNING
(Program Policy) Function
CUP
PROGRAM OPERATIONS CONTROL BOARD
TACTICAL UTILIZATION AND OPERATIONS PLANNING
(Program Integration) Function
TOP
PROGRAM OPERATIONS CONTROL BOARD
INCREMENT PLANNING
(Program Integration) Function
FIP
OPERATIONS CENTERS CONTROL BOARDS
INCREMENT EXECUTE PLANNING
(Program Execution) Function
EXECUTE PLANS & DATA
USERS

**Figure I-2 Recommended Framework Planning And Control Hierarchy**

Station User Board (SSUB) consisting primarily of user-sponsoring organizations.[4] Partner SSUB plans are brought together and reconciled by the internationally staffed strategic level boards provided by the MOUs.[5] Technical support is provided by the Program Policy level staff, or the Program Integration level utilization/operations organization. The yearly output of these boards is a Consolidated Utilization Plan (CUP) which contains the Program's "rough cut" projection of resource requirements for Station operations and user activities.

**Tactical Utilization and Operations Planning**

The CUP is passed to the tactical level utilization and operations organization. A Program Operations Control Board oversees the development of a two-year Tactical Operations Plan (TOP), which manifests users to specific flight increments. The internationally staffed Program Operations Control Board is located in the NASA Headquarters Program Office and enlists the support of the NASA field centers and partners in this function. At the head of this organization is the Director of Utilization and Operations. Figure I-3 illustrates the hierarchy of control functions at each management level.

In addition to manifesting user payloads on the manned base, the TOP also manifests system maintenance and resource requirements and contains logistics and STS/ELV/OMV transportation plans. TOP preparation is a continuous process during which changes to individual flight increments are negotiated and incorporated. (See following discussion on increment planning.)

A Space Station Users Working Group (SSUWG), consisting primarily of the users (or their discipline representatives) contained in the CUP will support the development of the TOP. A key feature of the Recommended Framework is the strong role played by users in operations planning. In addition, a Program-sponsored Payload Accommodation Manager (PAM) is assigned to each payload that appears in the CUP. The PAM provides the single point of contact for an individual user to the Station Program. The PAM stays with

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[4] *These include the NASA Offices of Space Science and Applications, Commercial Programs, Aeronautics and Space Technology, and Space Station (representing commercial reimbursable users), as well as representatives from other governmental agencies.*

[5] *Multilateral Control Board, User Operations Panel; and Systems Operations Panel.*

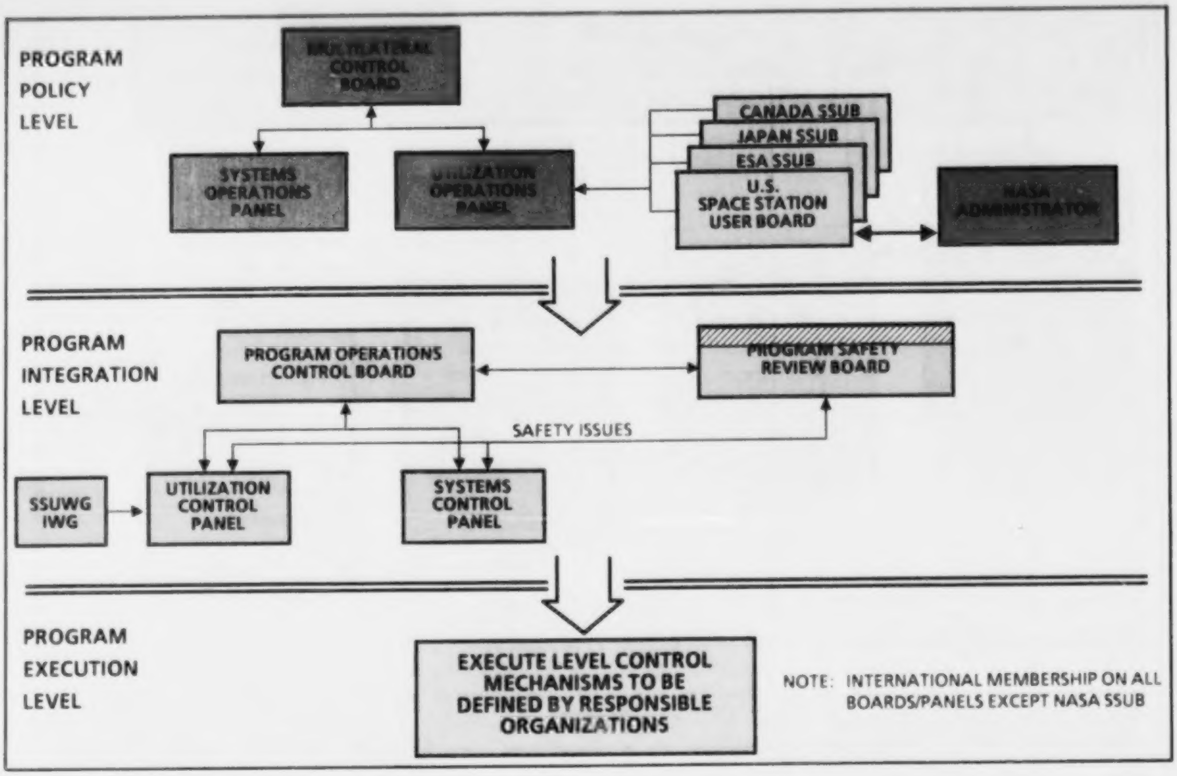
PROGRAM
POLICY
LEVEL
MULTILATERAL CONTROL BOARD
SYSTEMS OPERATIONS PANEL
UTILIZATION OPERATIONS PANEL
CANADA SSUB
JAPAN SSUB
ESA SSUB
U.S. SPACE STATION USER BOARD
NASA ADMINISTRATOR
PROGRAM
INTEGRATION
LEVEL
PROGRAM OPERATIONS CONTROL BOARD
PROGRAM SAFETY REVIEW BOARD
SAFETY ISSUES
SSUWG IWG
UTILIZATION CONTROL PANEL
SYSTEMS CONTROL PANEL
PROGRAM
EXECUTION
LEVEL
EXECUTE LEVEL CONTROL MECHANISMS TO BE DEFINED BY RESPONSIBLE ORGANIZATIONS
NOTE: INTERNATIONAL MEMBERSHIP ON ALL BOARDS/PANELS EXCEPT NASA SSUB

**Figure I-3 Program Control Summary**

the payload through its life-cycle with the Program, including design and development, manifesting, transport to orbit, operation and return. One PAM is expected to be able to work with several payloads at a time. Figure I-4 illustrates the flow of the strategic and tactical level planning functions.

### Increment Planning

The TOP becomes the basis for the generation of Flight Increment Plans (FIPs), covering the period of time between STS visits to the manned base. STS visits represent an opportunity for crew and equipment configuration change, and hence are the appropriate Operations Execution level planning milestones. Increment lengths will vary according to the number of STS visits per year.[6]

Increment planning is also a Program Integration level function, with greater involvement of Program Execution level offices for provision of the necessary technical support. Planning for user activities associated with each increment is developed by a Payload Operations Integration Center (POIC), with guidance from the users' Investigators Working Group (IWG) and within Space Station Support Center (SSSC) guidelines.

For manned base operations, Increment Change Managers[7] are assigned the authority and responsibility to manage the integration of Program and user operations requirements, plans and schedules for a specific increment. Typical senior management responsibilities of the Increment Change Manager will include: direct and expedite specific plans for the accommodation of manifested user requirements; integrate transportation and data system organization needs and capabilities into the manned base planning process; identify any increment-unique requirements for Program and user logistics and prelaunch/post-landing processing support; and identify the specific ground operator and onboard crew skills required to support increment objectives.

The NASA Headquarters SSP organization will maintain control over and be responsible for tactical and increment utilization and operations planning. In

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[6] *Assuming eight STS visits per year, increments are 45 days in length, and a TOP covers 16 increments. With five STS visits per year, increments are approximately 72 days long, with ten increments covered in a TOP.*

[7] *The term "Change" in the title reflects the fact that this manager will be responsible for coordinating those requirements which are new to an increment, as opposed to activities which carry-over from previous increments. It is expected that a substantial portion of manned base activity will be of the latter kind.*

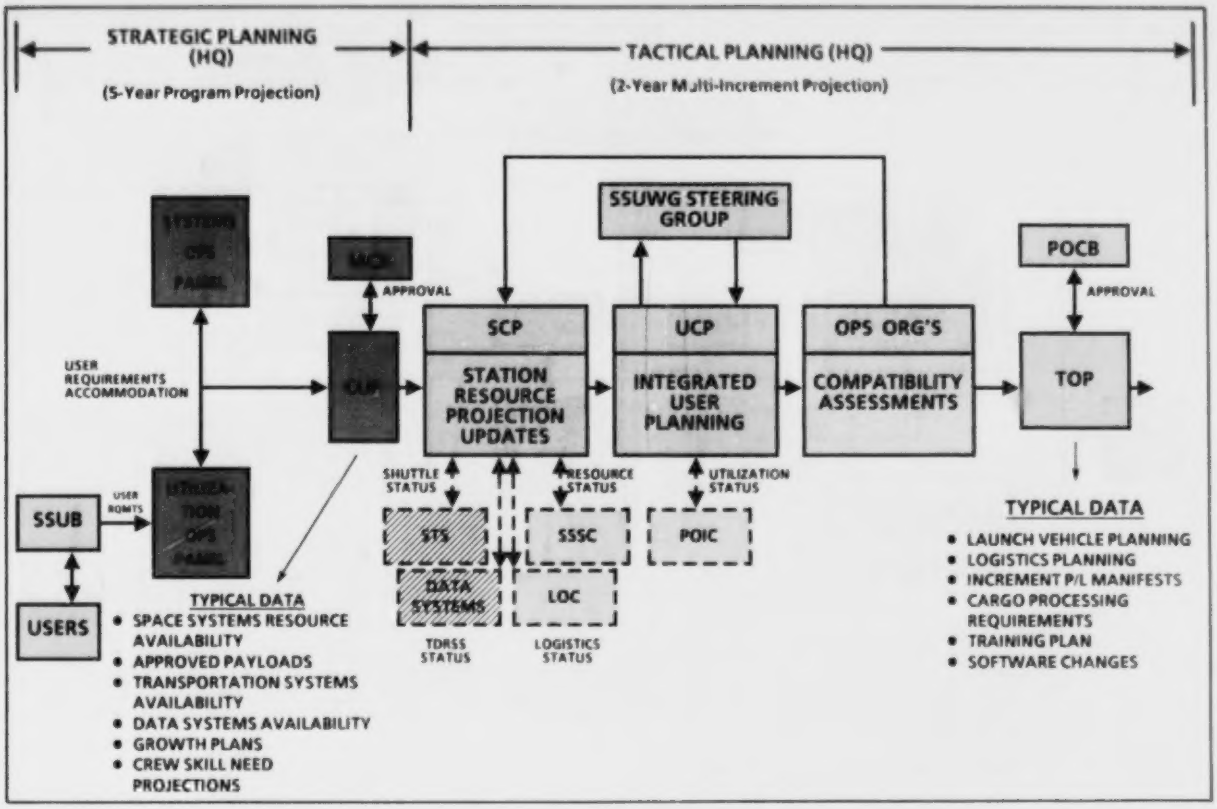
STRATEGIC PLANNING (HQ)
(5-Year Program Projection)
TACTICAL PLANNING (HQ)
(2-Year Multi-Increment Projection)
SYSTEMS OPS PANEL
APPROVAL
USER REQUIREMENTS ACCOMMODATION
CUP
SSUWG STEERING GROUP
SCP
STATION RESOURCE PROJECTION UPDATES
UCP
INTEGRATED USER PLANNING
OPS ORG'S
COMPATIBILITY ASSESSMENTS
POCB
APPROVAL
TOP
SSUB
USER RQMTS
UTILIZA-TION OPS PANEL
USERS
SHUTTLE STATUS
RESOURCE STATUS
UTILIZATION STATUS
STS
SSSC
POIC
DATA SYSTEMS
LOC
TDRSS STATUS
LOGISTICS STATUS
TYPICAL DATA
SPACE SYSTEMS RESOURCE AVAILABILITY
APPROVED PAYLOADS
TRANSPORTATION SYSTEMS AVAILABILITY
DATA SYSTEMS AVAILABILITY
GROWTH PLANS
CREW SKILL NEED PROJECTIONS
TYPICAL DATA
LAUNCH VEHICLE PLANNING
LOGISTICS PLANNING
INCREMENT P/L MANIFESTS
CARGO PROCESSING REQUIREMENTS
TRAINING PLAN
SOFTWARE CHANGES

**Figure I-4 Strategic And Tactical Planning Process Flow**

practice, it is expected that many of the technical analysis and support tasks will be delegated to the various field centers.

### Increment Execute Planning

Increment Execute Planning entails preflight development of detailed operations and utilization execution plans and related data, as well as the real-time replanning of operations in response to contingencies or new opportunities. Execution plans and related data are derived from the relevant FIP. Such plans include the Increment Operations Plan (IOP), Flight Data File (FDF), Increment Hazard Control Plan (IHCP), Flight Rules, Reconfiguration Data and other real-time execution plans and supporting documentation as called for in the FIP. Figure I-5 illustrates the flow of the increment planning and increment execute planning process.

## I.D. OPERATIONS EXECUTION

Operations execution includes the detailed functions associated with implementing flight increment schedules for prelaunch scheduling and processing, launch and transfer operations, on-orbit activity (including ground support), and return and postlanding activity. NASA field centers, international partner and user operations facilities will execute the plans and procedures derived from the Increment Execute Planning function. Location of operations activities and key functional characteristics are:

**Space Station Support Center (SSSC):** The SSSC is a Program-provided facility which centralizes systems management and control for the manned base, including the elements provided by the partners. Crew and manned base safety are SSSC responsibilities as well. A key role of the SSSC is to provide a "template" of systems management responsibilities and resource requirements which are used to schedule payload activity windows.[8] The SSSC also approves the resulting schedule of user and systems activities. Crew training facilities are closely associated with the SSSC (and POIC). International partners will support the conduct of operations for their elements by providing responsible flight control staff at the SSSC, as well as providing real-time engineering support from facilities located in their own countries.

**Payload Operations Integration Center (POIC):** The POIC is a Program-supplied facility whose function is to schedule user activities for the manned base, building on the template provided by the SSSC. It integrates the user requirements according to user resource envelopes and available resources provided by

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[8] *The SSSC template will allow for sliding schedules for noncritical systems activities to provide for time-critical payload activities.*

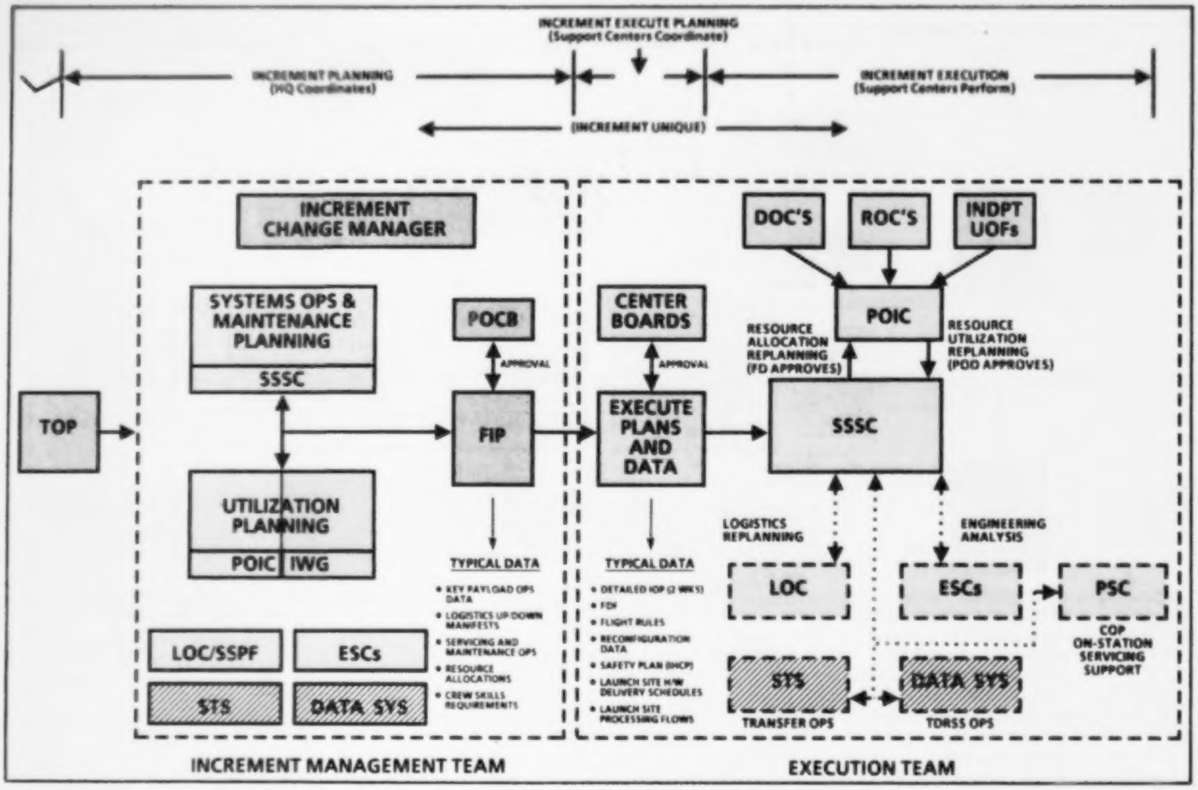

INCREMENT EXECUTE PLANNING
(Support Centers Coordinate)
INCREMENT PLANNING
(HQ Coordinates)
INCREMENT EXECUTION
(Support Centers Perform)
(INCREMENT UNIQUE)
INCREMENT CHANGE MANAGER
SYSTEMS OPS & MAINTENANCE PLANNING
SSSC
POCB
APPROVAL
TOP
FIP
UTILIZATION PLANNING
POIC
IWG
TYPICAL DATA
• KEY PAYLOAD OPS DATA
• LOGISTICS UP/DOWN MANIFESTS
• SERVICING AND MAINTENANCE OPS
• RESOURCE ALLOCATIONS
• CREW SKILLS REQUIREMENTS
LOC/SSPF
ESCs
STS
DATA SYS
INCREMENT MANAGEMENT TEAM
DOC'S
ROC'S
INDPT UOFs
POIC
RESOURCE ALLOCATION REPLANNING (FD APPROVES)
RESOURCE UTILIZATION REPLANNING (POD APPROVES)
CENTER BOARDS
APPROVAL
EXECUTE PLANS AND DATA
SSSC
TYPICAL DATA
• DETAILED IOP (2 WKS)
• FDF
• FLIGHT RULES
• RECONFIGURATION DATA
• SAFETY PLAN (HCP)
• LAUNCH SITE H/W DELIVERY SCHEDULES
• LAUNCH SITE PROCESSING FLOWS
LOGISTICS REPLANNING
ENGINEERING ANALYSIS
LOC
ESCs
PSC
COP ON-STATION SERVICING SUPPORT
STS
DATA SYS
TRANSFER OPS
TDRSS OPS
EXECUTION TEAM

Figure I-5 Increment And Increment Execute Planning Process Flow

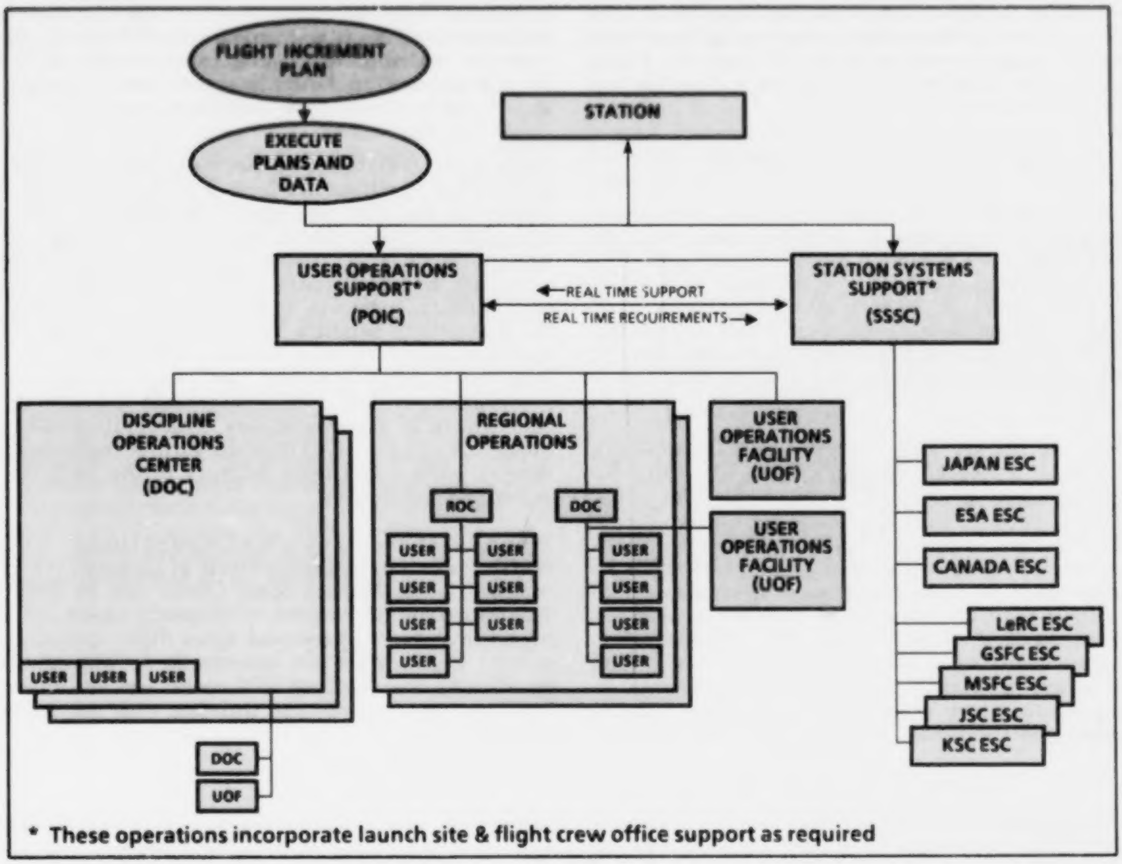
the SSSC, assists users in periodic "replanning," aids the IWG in user conflict resolution, and supports distributed user facilities in real-time or near real-time execution activities. Thus, on-orbit crew time and other resources available for users are managed by the POIC in cooperation with the SSSC. The SSSC will normally be transparent to the user community during routine payload operations.

**User Operations Facilities:** A variety of user-supplied and operated facilities are envisioned to meet specific needs of the users. They can be equipped to support the range of user operations involved in payload management (i.e., command, control and communications for experiments, data analysis and storage, etc.). These facilities shall be established according to user preference. However, the SSOTF foresees three basic approaches: (1) Discipline Operations Centers (DOCs); (2) regional operations facilities; and (3) stand-alone or proprietary User Operations Facilities (UOFs) maintained by a single user or group of users. (See Figure I-6.)

DOCs are user-supplied and operated facilities which provide support to a discipline user group which is centered around a specific area of investigation. They are intended to allow for the sharing of technical support and overhead costs to users with similar discipline needs. The DOCs will interface with the POIC for coordination of their payload planning activity, and may be affiliated with a regional operations facility as well. They may also be affiliated with a number of independent UOFs. Examples of discipline categories include: materials science, life science, technology development, earth observation, etc.

Regional operations facilities incorporate both Regional Operations Centers (ROCs) and affiliated DOCs. The ROCs are user (or partner) supplied and operated facilities which are geographically focused to provide support to regionally based user groups. The intention is to share common overhead costs or technical interests with regionally grouped users. A ROC will include facilities to support user operations integration functions and coordinate disparate user activities during flight preparation and execution. ROCs will interface with the POIC for support in scheduling and real-time replanning activities. ROCs may be affiliated with different DOCs or a number of independent UOFs within a regional operations structure.

Stand alone or proprietary UOFs may be physically co-located at NASA or partner sites or at user-selected industrial, research or academic sites. Each may be affiliated with a DOC or ROC or may report directly to the POIC for integration of plans and requirements with those of other users.


FLIGHT INCREMENT PLAN
EXECUTE PLANS AND DATA
STATION
USER OPERATIONS SUPPORT* (POIC)
REAL TIME SUPPORT
REAL TIME REQUIREMENTS
STATION SYSTEMS SUPPORT* (SSSC)
DISCIPLINE OPERATIONS CENTER (DOC)
USER
USER
USER
DOC
UOF
REGIONAL OPERATIONS
ROC
DOC
USER
USER OPERATIONS FACILITY (UOF)
USER OPERATIONS FACILITY (UOF)
JAPAN ESC
ESA ESC
CANADA ESC
LeRC ESC
GSFC ESC
MSFC ESC
JSC ESC
KSC ESC

* These operations incorporate launch site & flight crew office support as required

**Figure I-6 Manned Base Operations Framework**
**Real-Time Operations -- Systems And User Support**

**Platform Support Center (PSC):** The SSSC and POIC functions are combined for platform operations in a PSC. It is likely that two will exist; one for the U.S. polar and co-orbiting platforms, and one in Europe for the ESA polar orbiting platform.

**Space Station Processing Facility (SSPF):** The SSPF will house the prelaunch processing activity for all Space Station hardware to be transported to orbit via the STS. (Similar facilities will exist at other launch sites.) In the Mature Operations Phase, the logistics flight hardware will undergo prelaunch and postlanding processing ("turnaround"). The partners' flight hardware may be processed in this facility as well, with element-unique activity the responsibility of the providing partner, and integration activity led by NASA with partner participation. The SSPF will perform all interface and safety verification testing for the Program before delivering payloads and carriers to the transportation operations organization for STS or ELV integration.

Payload integration will be performed in a modified "ship and shoot" mode. Users may build and/or integrate racks and experiments at "Science and Technology Centers" certified by the Program. These centers will be located at NASA field centers, partner facilities, or user facilities, and are likely to evolve from existing institutional payload development capabilities. As an optional service, launch sites will also have a capability to build up and/or integrate payloads for users. All payloads and orbital replacement units (ORUs) will undergo final interface testing at the launch site.

**Logistics Operations Center (LOC):** Program-wide logistics support operations are centrally located and managed. Key aspects of LOC functions include management of logistics information and data bases, inventories (ground and onboard), configuration, transportation systems interface, packaging, handling and ground transportation. The LOC will support a line item population on the order of 300,000, including 2,500 orbital replacement units (ORUs). A key feature of the LOC is its extensive use of automated test equipment for in-house maintenance and repair.

**Engineering Support Centers (ESCs):** Located at the NASA and partners' hardware development centers and the launch site(s), these facilities will provide engineering and real time consultation support on an on-call basis. They also will perform sustaining engineering in the Development and early Mature Operations Phases. The SSOTF Framework calls for development of a transition plan which would eventually centralize sustaining engineering for U.S. orbital elements. Sustaining engineering for ground support systems and information systems would remain distributed to the U.S. operations centers and the partners' sites.

## I.E. ROLES AND RESPONSIBILITIES

Figure I-7 provides a summary overview of the entire flow from strategic through execution operations. As noted above, the Framework recommends a centralized planning and management function led by NASA with the participation of the international partners at all levels. The following operations roles are recommended to be assigned to the following field centers and international partners for the Mature Operations Phase:

**Program policy and integration** functions are performed at NASA Headquarters. The SSOTF assigned these functions to Headquarters for many reasons. These include the ability to provide a single interface for issues affecting the international partners; the necessity to manage and integrate the operations of multiple operations centers; the need to establish close coordination at senior management levels between the Space Station, space transportation, communications and data services utilization and operations planning organizations; the need to integrate long term planning for operations with the budget development process; and the need to strengthen Program management. NASA leadership in these functions is predicated upon NASA's larger resource contribution to program development and operations, and on NASA's significantly greater experience in manned space flight operations.

**Integrated logistics and prelaunch/postlanding processing** functions are located at Kennedy Space Center in the LOC and SSPF, respectively. This assignment takes advantage of KSC's depth of experience in NASA manned programs (including prelaunch and postlanding processing, logistics and transportation services). It also offers the opportunity for synergistic benefits by coordinating with the logistics support and payload processing and integration activities already performed by the STS organization at KSC. This assignment includes the integration of space systems ORU maintenance requirements as received from the various engineering support centers and their delivery to the SSSC for planning and execution.

**Manned base systems operations and maintenance implementation** responsibility is assigned to the Johnson Space Center and its SSSC. This will allow the Program to efficiently utilize JSC's expertise as the lead manned space flight operations center. It also offers the opportunity for synergistic benefits by coordinating STS operations activities, facilities, crew support and training with the SSP's counterparts.

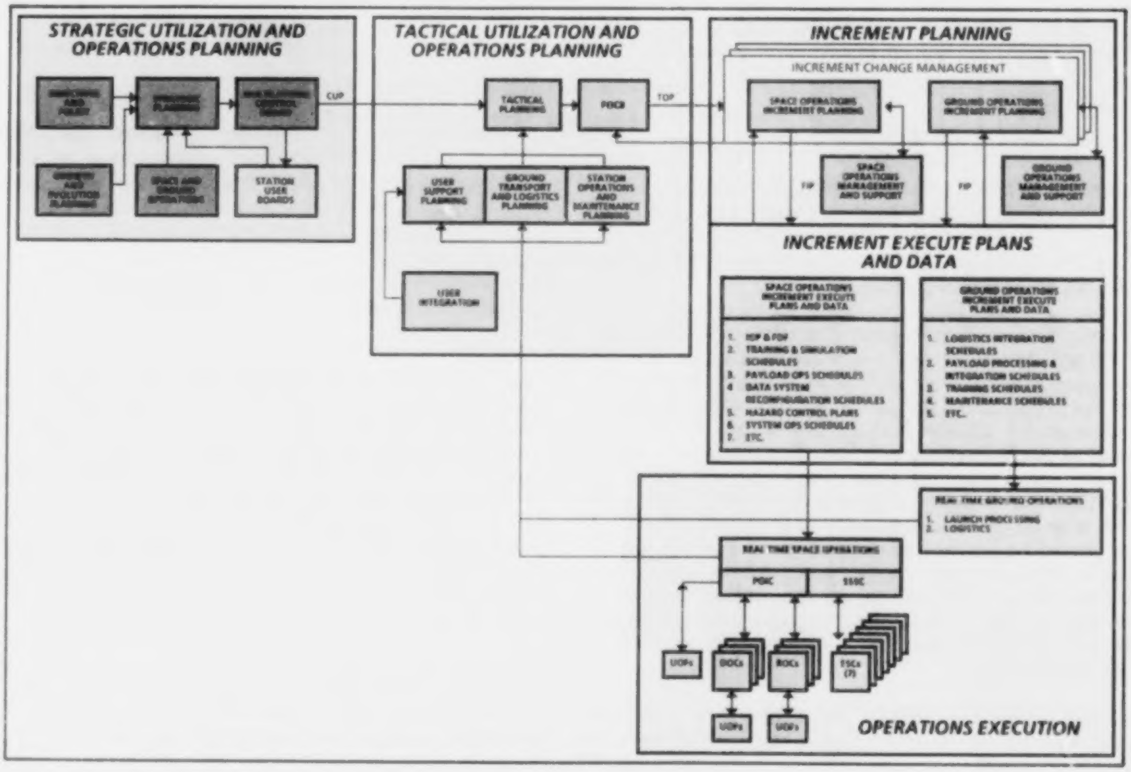

STRATEGIC UTILIZATION AND OPERATIONS PLANNING
STATION USER BOARDS
CUP
TACTICAL UTILIZATION AND OPERATIONS PLANNING
TACTICAL PLANNING
TOP
USER SUPPORT PLANNING
GROUND TRANSPORT AND LOGISTICS PLANNING
STATION OPERATIONS AND MAINTENANCE PLANNING
USER INTEGRATION
INCREMENT PLANNING
INCREMENT CHANGE MANAGEMENT
SPACE OPERATIONS INCREMENT PLANNING
GROUND OPERATIONS INCREMENT PLANNING
FIP
SPACE OPERATIONS MANAGEMENT AND SUPPORT
FIP
GROUND OPERATIONS MANAGEMENT AND SUPPORT
INCREMENT EXECUTE PLANS AND DATA
SPACE OPERATIONS INCREMENT EXECUTE PLANS AND DATA
2. TRAINING & SIMULATION SCHEDULES
3. PAYLOAD OPS SCHEDULES
4 DATA SYSTEM RECONFIGURATION SCHEDULES
5. HAZARD CONTROL PLANS
6. SYSTEM OPS SCHEDULES
7. ETC.
GROUND OPERATIONS INCREMENT EXECUTE PLANS AND DATA
1. LOGISTICS INTEGRATION SCHEDULES
2. PAYLOAD PROCESSING & INTEGRATION SCHEDULES
3. TRAINING SCHEDULES
4. MAINTENANCE SCHEDULES
5. ETC.
REAL TIME GROUND OPERATIONS
1. LAUNCH PROCESSING
2. LOGISTICS
REAL TIME SPACE OPERATIONS
POIC
SSSC
UOPs
ROCs
TSCs (7)
UOPs
UOPs
OPERATIONS EXECUTION

Figure I-7 Summary: Manned Base Operations Framework

**Manned base user operations integration** is delegated to the Marshall Space Flight Center and its POIC. This includes the integration of user requirements for ground and onboard payload operations and servicing. MSFC is the development center for the U.S. laboratory module and will have developed the detailed "corporate knowledge" of this user-oriented element. MSFC also has existing expertise through its role in the Spacelab Program and its associated Payload Operations Control Center. Finally, the SSOTF felt that assignment of user operations integration activities to MSFC would establish a stronger "user-directed" activity than would be the case if it were co-located with system operations activities.

**U.S. platform operations** are assigned to the Goddard Space Flight Center and its PSC. GSFC's development role for the platforms, its expertise in past unmanned systems operations, its experience in supporting the platform science and application user community, opportunities for synergy with existing platform facilities, and the Task Force's conclusion that platform and manned base operations should be separately operated all led to this decision.

**ESA platform operations** are assigned to the European Space Agency and its PSC for the same reasons that the U.S. platforms are assigned to GSFC. In addition, it was noted that ESA plans to develop a European Data Relay Satellite (EDRS) and associated ground systems would undoubtedly require close cooperation between the ESA platform operator and the EDRS development organization.

**Engineering support** is initially distributed to ESCs staffed by the NASA field center and international partner organizations responsible for the development of the major Station elements (MSFC, JSC, GSFC, LeRC, KSC, ESA, Japan, Canada). It was judged that this would facilitate a smooth transition from development engineering to sustaining engineering as the various Station systems are assembled and mature into full operational status. Once the fully integrated Station is demonstrated to be operationally mature (systems are stable and reliable and their performance characteristics predictable), consideration will be given to centralizing the sustaining engineering function for U.S. orbiting elements at KSC.

# II. SPACE STATION PROGRAM OVERVIEW

The Space Station Program will be the keystone of NASA's space efforts for the next three decades. The Program will offer a dynamic resource base for conducting both manned and unmanned science in space, as well as providing an expanded capability to conduct "traditional" space science and applications. It will also support a variety of new space operations such as commercial research and pilot production activities utilizing the unique properties of the space environment. Part laboratory, part observatory, part servicing and repair facility, the Space Station will greatly expand America's existing space capabilities. With a Program lifetime of up to 30 years, operating the Space Station will place new and challenging demands on NASA and the participating international partners.

## II.A. SPACE STATION PROGRAM GOALS

Given the size and importance of the Space Station to the civilian space program, it is not surprising that its mission goals are extensive. The SSOTF endeavored to construct its operations framework to support the overall goals of the Program. The following goals were compiled by the SSOTF from published Program documentation, and fall within four broad categories: (1) encourage scientific and technological development and discovery in utilizing the space environment; (2) leverage such discoveries into tangible, long-term national economic benefit; (3) improve space operations by improving effectiveness and reducing costs; and (4) support the foreign policy goals of the United States by promoting international cooperation in the peaceful uses of outer space. These goals are summarized in Table II-1.

### II.A.1. Scientific Technological Development and Discovery

The primary goal of the Space Station Program is to provide user-oriented capabilities which fulfill the NASA mandate for discovery, exploration, and utilization of the space environment. The Space Station's closest historical analogies for manned spaceflight are the Skylab and Spacelab programs, which were developed as general purpose support facilities for science and technology development. The Space Station's platforms are analogous to previous unmanned scientific satellites and will be operated much the same as past and present "free flyer" programs. In contrast with its predecessors, however, the Station Program embodies considerably broader objectives. The Station must serve a wider range of "customers" for a much longer period of time.

A second aspect of this goal is to advance America's space technology base through development of new technologies utilizing the Station's hardware and software capabilities. In this fashion, the Space Station can provide facilities for the testing of advanced systems which are necessary for future projects such as a permanent manned presence on the moon or a manned mission to Mars. Like the user-support goal, this objective is quite broad in scope, covering all of the technological disciplines that are embodied in space systems.

| SCIENTIFIC AND TECHNICAL DISCOVERY | NATIONAL ECONOMIC RETURN | IMPROVE THE EFFECTIVENESS OF SPACE OPERATIONS | FOREIGN POLICY |
|---|---|---|---|
| • User-Orientation<br>• Enhance space science and applications<br>• Stimulate advanced technology development | • Enhance U.S. aerospace productivity<br>• Support commercial utilization of the space environment<br>• Spin-off of technology to U.S. industry | • Reduce the "unit cost" of space operations<br>• Design and operate for life-cycle cost<br>• Optimize scarce resources, especially crew<br>• Reduce operations costs through<br>-- Maintainability<br>-- Commonality<br>-- Modularity<br>• Optimize design and operations for evolution | • Promote cooperation with U.S. allies in civil space programs<br>• U.S. national prestige |

Table II-1 Space Station Program Goals

### II.A.2. National Economic Return

NASA's technology base has been, and continues to be, a valuable industrial asset to the nation's economy. While early NASA programs were not specifically designed to generate "spinoffs" to industry at large, experience shows that NASA's development of new technical capabilities has led to breakthrough technologies of interest to industry and accelerated technology development in many areas. These direct spinoffs to the aerospace and computer industries have enhanced their productivity and international competitiveness.

A second aspect of this goal is to support the development of commercial space initiatives. The public investment in the NASA program is analogous to earlier support by the government in the infrastructure of commerce. Waterways, railways, aviation and the interstate highway system are all examples of public sector investments which were undertaken to stimulate economic enterprise. Early investments in space transportation systems and satellite technology precipitated the commercial communications satellite industry; likewise, the presence of permanent laboratory facilities in space should serve as a catalyst for innovative commercial research and development, and the commercial provision of space products and services.

The third aspect of this goal is the stimulation of technologies of benefit to U.S. industry as a whole (as opposed to aerospace applications alone). As noted above, the space programs of the 1960s paced many of the advances in computer technology. The U.S. Congress has become especially interested in the industrial benefits of investment in the Space Station, and has specifically directed NASA to highlight advanced automation and robotics technologies. Other technologies of interest to Station operations include information systems, environmental control and monitoring, solar power generation and storage, and waste management.

### II.A.3. Improved Effectiveness of Space Operations

Space is a demanding environment, and these demands are reflected in the high cost of space hardware and operations. As a result, there has been a concerted effort in the U.S. space community to understand the factors which drive costs, and to reduce them wherever possible.[1] Numerous studies conducted by both NASA and the Department of Defense have cited underestimation of operational factors as a major driver of costs. This is especially important for the Space Station Program, since its operations lifetime is projected to span three decades.

The importance of operations costs forces NASA to approach design and operations from a life cycle cost perspective. Design must be linked to anticipated system and user requirements in the Mature Operations Phase so that proper tradeoffs can be made. (The least costly design may cost more to operate than it saves in development cost.)

One specific method for reducing the costs of operations is to effectively use scarce resources on the manned base. Crew time will be one of the most expensive and scarce "resources"; power will be another. To make optimal use of crew time, operations should influence both the design process and the development of operations procedures and schedules. This suggests design decisions incorporating human factors engineering and performing trades between assigning tasks to automated systems, crew, or ground support personnel. It also suggests designs and operational techniques permitting non-critical control, monitoring, and maintenance tasks to be performed by automated means or by remotely controlled systems.[2] In performing these analyses, the guiding principle should be "have men perform tasks which require man's presence." Other criteria which must be considered are safety, the availability of technology, and costs.

A second method is to develop common and easily maintained hardware and software whenever possible. Emphasis for space hardware, software, and data system interfaces should include such factors as common standards, the development of common "orbital replacement units" (ORUs) across hardware elements, and the inclusion of fault isolation, self-test systems, accessibility and ease of handling/replacement in systems design. Modularity, common interfaces, and "oversizing" (i.e., providing overcapacity) of such elements as data management system components are essential if systems are to be easily upgraded over time. The Program should also strive to develop common safety and payload integration requirements for Space Station, taking into account the STS so that users do not have to respond to varying requirements. Likewise, logistics and space operations support to both programs should derive benefits from developing common standards, procedures, and equipment.

A third method is to design and operate the manned base as an "organic facility" which can evolve to meet changing user requirements and to take advantage of new capabilities as they become available. To achieve this goal and allow for minimum intrusion in on-going activities when new capabilities are added, the initial systems should be designed for technology transparency (i.e., allowing for minimum disruption by making the addition of new technologies as simple as possible). Once again, this goal reinforces the goal of industrial spinoffs, as many of the anticipated advances in Space Station technology would be of interest to industry at large.

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[1] *Another way of looking at this goal is to consider it from the productivity standpoint: to increase the amount of "return" per unit of cost.*

[2] *These Program goals are often reinforcing. For example, development of advanced robotics capabilities not only maintains U.S. technological pre-eminence, but could also reduce the cost of space operations, and will likely provide a source of innovative concepts for earth-based industry.*

### II.A.4. International Cooperation

The NASA space program has always been an effective mechanism for promoting U.S. foreign policy. Cooperative scientific endeavors provide tangible benefits to cooperation in both the short and long term.[3] First, both NASA and its partners will benefit from the pooling of resources: users will have a facility with much greater capability than if each partner had developed separate facilities. Thus, the partners are expected to make substantial technological contributions to the Program.

Secondly, it is clear that NASA's partners will continue to expand their space capabilities. The partners will, sooner or later, replicate the functional capabilities which NASA has in both manned and unmanned space operations. This suggests that: (1) the opportunities for cooperation will continue to proliferate; and (2) to maximize the potential for continued cooperation, NASA and its partners should develop policies, procedures, and protocols which are mutually beneficial as well as being supportive of specific national goals.

This process recognizes that U.S. and partner goals in the Program will not always coincide. (To the extent that NASA's partners develop their own technology base through the Program, they challenge the market position of U.S. industry.) Hence, both the development and operations aspects of the Program will require some compromise among these goals.

## II.B. CHARACTERIZING SPACE STATION OPERATIONS

Operations functions and the concepts for supporting them are derived from analysis of the Space Station's hardware elements and their intended uses. This section is a summary of the major aspects of the Space Station Program's hardware configuration, and provides a "snapshot" of the kinds of activity which will occur during operations.

### II.B.1. Space Station Configuration

The SSOTF was given the reference configuration published by NASA's Critical Evaluation Task Force (CETF) in September 1986 as its baseline. This configuration defined the Station's hardware elements, and the resource capabilities which they provide.[4]

The major space-based elements of the Space Station Program are the manned base and unmanned platforms. (See Figure II-1.) The manned base will consist of four pressurized modules: two supplied by NASA (one for use as a laboratory and one for habitation); a second laboratory supplied by the European Space Agency (ESA); and third supplied by the National Space Development Agency of Japan (NASDA).[5] The platforms will consist of a co-orbiting platform and a polar orbiting platform (COP and POP, respectively) supplied by the United States. ESA will also supply a polar orbiting platform which will operate independently of the U. S. platforms.

On the manned base, the pressurized modules will provide the main living and working quarters for an international crew of eight. Four "Resource Nodes" will connect the modules, and provide additional working space. Current plans call for the manned base's control systems to be located in the nodes. While the modules will be contributed by different partners, they will share a complex network of "distributed systems": environmental control and life support (ECLS); guidance, navigation and control (GN&C); propulsion; power; data management; communications and tracking; structures and mechanisms; fluids; and thermal management.

The modules and nodes will be attached to a large truss structure supplied by NASA. The truss will also support the photovoltaic and solar dynamic power systems for the manned base,[6] an unpressurized satellite servicing facility (see below), and provide a base for mounting payloads which do not require continual man-tending or an atmosphere.

A Canadian-built Mobile Servicing Center (MSC) will allow astronauts inside the pressurized modules to manipulate exter-nally mounted (or "attached") payloads, to bring transportation vehicles in for "soft docking", and to perform routine inspection and maintenance of the outside of the manned base. The MSC has a large robotic arm mounted on a moving base

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[3] *The SSOTF was directed to assume that the Space Station Program will include international partners in both development and operations. It was further directed by the SSOTF Oversight Committee to assume that the U.S. will play the lead role, consistent with its dominant financial contribution to the program and its more extensive experience in manned space systems.*

*Importantly, there will likely be considerable "cross-utilization" - U.S. researchers working in foreign modules (a substantial portion of the resources of the foreign elements will be reserved for U.S. users by international agreement), and foreign researchers using U.S. modules. Such resource sharing will impose significant integration and planning requirements on the Program.*

[4] *The CETF also proposed an assembly sequence for delivery by the Shuttle of these elements to orbit. The SSOTF used this as the baseline for evaluating the transition phase of their operations concepts. The recent decision by NASA to propose a two-phased approach to Program development does not materially alter the operations environment for Station activities, but lengthens the time between development and final mature operations of the manned base and the platforms.*

[5] *The European Space Agency laboratory module is known as "Columbus"; Japan is supplying the Japanese Experiment Module (JEM) for use as a lab. The JEM will also include an exposed payload facility for mounting racks of experiments, a robotic arm operated from inside the JEM, and a logistics module for storing equipment and payloads used in the JEM. It is expected that as the manned base evolves over time, additional modules will be added to the four which are part of the baseline configuration.*

[6] *Phase I plans call for initial deployment of a 75kw photovoltaic array; solar dynamic power systems will be added in the Phase II configuration for a total system power of up to 150kw.*

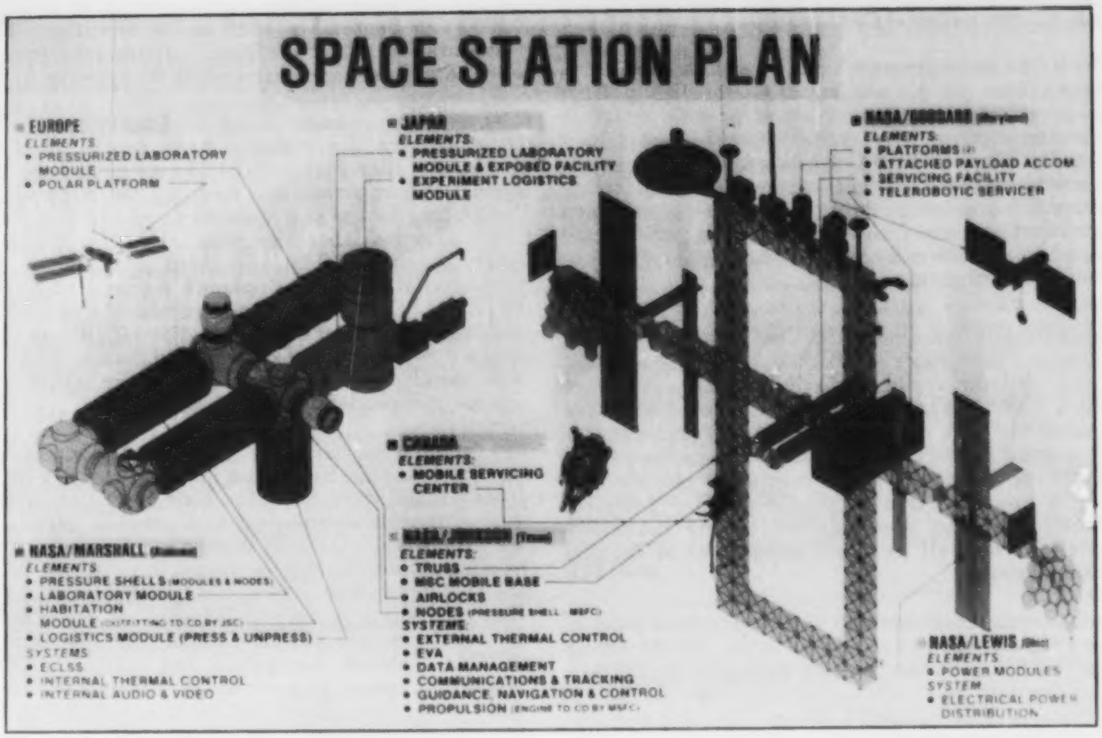
SPACE STATION PLAN
EUROPE
ELEMENTS:
• PRESSURIZED LABORATORY MODULE
• POLAR PLATFORM
JAPAN
ELEMENTS:
• PRESSURIZED LABORATORY MODULE & EXPOSED FACILITY
• EXPERIMENT LOGISTICS MODULE
NASA/GODDARD
ELEMENTS:
• PLATFORMS (2)
• ATTACHED PAYLOAD ACCOM
• SERVICING FACILITY
• TELEROBOTIC SERVICER
CANADA
ELEMENTS:
• MOBILE SERVICING CENTER
NASA/MARSHALL
ELEMENTS:
• PRESSURE SHELLS (MODULES & NODES)
• LABORATORY MODULE
• HABITATION MODULE (OUTFITTING TO CD BY JSC)
• LOGISTICS MODULE (PRESS & UNPRESS)
SYSTEMS:
• ECLSS
• INTERNAL THERMAL CONTROL
• INTERNAL AUDIO & VIDEO
NASA/JOHNSON
ELEMENTS:
• TRUSS
• MSC MOBILE BASE
• AIRLOCKS
• NODES (PRESSURE SHELL - MSFC)
SYSTEMS:
• EXTERNAL THERMAL CONTROL
• EVA
• DATA MANAGEMENT
• COMMUNICATIONS & TRACKING
• GUIDANCE, NAVIGATION & CONTROL
• PROPULSION (ENGINE TO CD BY MSFC)
NASA/LEWIS
ELEMENTS:
• POWER MODULES
SYSTEM
• ELECTRICAL POWER DISTRIBUTION

Figure II-1 Space Station Program Elements

which will "crawl" over the trusswork to perform these tasks. The robotic arm will be supplied by Canada; NASA will sponsor development of the mobile base. The MSC will also have a set of controls attached to its base which will allow astronauts to use it during EVA.

The U.S. will supply an unpressurized servicing facility which will be attached to the truss. It will enable astronauts to berth, store, assemble, repair, refuel, refurbish and test free-flyers and attached payloads. The facility will contain an in-bay manipulator system with effectors (hands) that is teleoperated from a control station.[7]

The manned base will have a number of additional hardware elements which increase crew capability. Another robotics device known as the Flight Telerobotics System (FTS) will attach to the Orbital Maneuvering Vehicle (OMV).[8] The FTS/ OMV will be able to grapple satellites and bring them to and from the manned base or Shuttle for servicing. The FTS/OMV will also be able to carry modular "orbital replacement units" out to the unmanned platforms, and carry out on-site servicing of satellites without having to bring them back to the manned base.

Unmanned platforms will support a broad range of scientific and technology development activities. NASA will provide platforms in polar orbit and the same 28.5 degree inclination orbit as the manned base (co-orbiting); ESA will provide an additional platform in polar orbit.[9] The platforms will be much larger than most present-day platforms, and will thus support more and larger experiments. Station platforms are designed for on-orbit changeout of payloads and servicing, as compared with current platforms which are "thrown away" when their payload mission is completed.

The Space Station will utilize logistics carriers to transport pressurized cargo (e.g., life sciences experiments), unpressurized cargo (e.g., tools, new instruments, spare parts, etc.), propellants, and fluids. The largest of these will be the pressurized logistics module, which will attach to a resource node on the manned base for shirtsleeve access by the crew. The logistics carriers will be ferried to and from the manned base and the platforms by the STS and, possibly by expendable launch vehicles.

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[7] *This facility is part of the Phase II configuration.*

[8] *The first OMV will be Shuttle-based; eventually, a second OMV will be permanently based at the manned base.*

[9] *Polar orbits are especially well suited to Earth observation missions, since they orbit the entire surface of the globe. Sun-synchronous polar orbits allow the satellite to make its passage at the same local time daily on successive passes. A 28.5 degree inclination (the standard orbit from a due-east launch from Kennedy Space Center) is good for space observation missions, and for locating payloads that must be serviced or "harvested" by the manned base or STS. The NASA co-orbiting platform is now part of the Phase II configuration.*

Integrated throughout all of the hardware elements is a Space Station Information System (SSIS) which uses existing and planned NASA, partner, and user-supplied space and ground communications systems. The manned base will have an internal communications system which is tied to the ground through the NASA Tracking and Data Relay Satellite System (TDRSS). Likewise, U.S. platforms will use the TDRSS for the relay of data to and from the Platform Support Center. A Data Interface Facility at the TDRSS ground terminal in New Mexico will serve as a "communications node" for distributing user data coming down from the Station (via TDRSS) to users at geographically dispersed locations. The NASA Communications Network (NASCOM) supports the transfer of real-time operations data among all of the ground control centers. The Program Support Communications Network (PSCN) will tie together all of the "off-line" data bases and administrative communications required to keep the Station functioning efficiently (including the Technical Management and Information System - "TMIS").

This Space Station Program infrastructure will have a number of uses over the lifetime of the Program. These include:

- A microgravity laboratory to conduct experiments and technology development activities in the fields of life and materials sciences;
- An observatory to conduct Earth observations (climate, earth resources, geodesy, oceanography and geology); and for planetary, solar and deep space astronomy and physics;

### *KEY FEATURES OF THE SSIS ARCHITECTURE*

*The Space Station Information System (SSIS) will be an end- to-end data and information system for the Space Station Program and its users. The SSIS contains a collection of flight and ground elements that are provided by NASA, the international partners, and users of the Space Station. As defined in the SSIS Architecture Definition Document, the SSIS supports "the functions of prelaunch checkout, mission management, scheduling and control, software development, and the acquisition, transmission, recording, processing, accounting, storage, and distribution of data (including audio and video) produced by the Space Station Program, its users, and interfacing space and ground elements."*

*From this functional definition it is evident the SSIS is broader than just those systems supporting flight critical activities. As interpreted by the Task Force, the SSIS includes real-time networks supporting flight activities and non real-time networks supporting Program management, Program development, and flight and ground operations activities. The SSIS also provides interfaces to separate networks which may be supplied by the international partners or Space Station users.*

*The real-time networks include onboard data and communications capabilities (both spacecraft systems and payloads), ground control center systems, and the communications links between flight and ground elements. These links are provided by NASA's Tracking and Data Relay Satellite System (TDRSS) for space-ground communications and the operational NASA Communications Network (NASCOM) for ground data transport. The Goddard Space Flight Center manages and controls the TDRSS and NASCOM and provides information system services in response to requests generated by the SSSC for the manned base and its users, the PSC for the platforms and its users, and the Shuttle Mission Control Center (MCC) for the Space Transportation System, the OMV, and their users. The manned base and platforms will require the equivalent of one full-time TDRS link each to support system and payload operations. Using these capabilities, the SSIS can support real-time operational communications for data, voice, and video at transmission rates of up to 300 mbps. The SSIS also supports the concept of telescience for support to users. In this mode of operation, SSIS services are transparent to the user permitting a direct, real-time communications path between the user's facility and the user's payload onboard either the manned base or the platforms.*

*Non real-time SSIS elements include the Technical Management Information System (TMIS) and the Software Support Environment (SSE). TMIS is an integrated, information system at each of the NASA Centers, the partner sites, and the prime contractors responsible for building Program elements. The SSE is a network of distributed Software Production Facilities. The SSE is responsible for establishing and maintaining standard tools, rules, procedures, and software development hardware for use in developing, maintaining, and upgrading software products. Communications services supporting these elements are provided by NASA's Program Support Communications Network (PSCN), an administrative network managed by the Marshall Space Flight Center.*

*All of the SSIS elements will have the capability to protect the handling and transmission of proprietary or sensitive data. However, the SSIS is not being designed to comply with Department of Defense computer or communications security requirements.*

*The SSIS is a complex, global information system. Given the number of interfaces (the SSIS ADD has over 50 ground locations identified), the different types of interfaces (e.g., data, voice, video), and the different functional uses of the communications links (e.g., from command and control to routine program planning), there is no simple method of illustrating the network. Figures II-2 and II-3 are top-level charts illustrating the manned base and platform operations infrastructure. The SSIS is used to provide the communications connectivity among all of the sites shown in these figures. Readers interested in additional details should consult Section IV.I. of this report, the SSIS ADD (JSC Document 30225), and the Space Operations and Support Systems panel report.*

*It should be noted that the Task Force SSIS architecture differs from the currently baselined SSIS ADD in terms of functional capabilities and locations for various ground- based centers. (See Section IV.I.) These differences will be resolved as the definition of the SSIS is refined. It should also be noted that SSIS elements will be provided by different organizations both within and external to NASA. Additionally, not all of the capabilities required by SSIS are dedicated to Space Station activities (e.g., TDRSS and NASCOM support all near-earth orbiting NASA spacecraft). These factors pose complex management and integration problems for the Program. To assist in resolving these problems, the Task Force recognized the need to have a single organization responsible for definition and control of SSIS architecture requirements.*

- An assembly facility for the assembly of large space structures or spacecraft, or integration with orbital transfer systems;
- A servicing facility where spacecraft and payloads may be resupplied, maintained, upgraded or repaired;
- A transportation node for deployment of spacecraft into different operational orbits using both throwaway and reusable orbital transfer systems;
- A manufacturing testbed for "scale-up" of equipment and processes for the on-orbit production of products which cannot be made on Earth; and
- A storage depot for experiments, equipment, consumables, and spare parts.

### II.B.2. Operations Activities

A typical day's activity for the manned base will be analogous to the operation of a multifunctional research and development complex on Earth. The major difference, of course, will be its location (in space and physically separated from its support facilities) and the unique requirements it places on those who maintain and use it. Typical operations activities for the manned base and unmanned platforms are depicted in Figures II-2 and II-3. These include: operations and utilization planning (determining who uses which resources and for what purposes, and planning for long term systems evolution); logistics operations support (the prelaunch activities associated with preparing the crew, consumables, and user instruments for launch to either the manned base or a platform and postlanding activities upon return); space operations (activities which transpire in orbit); and space operations support (ground-based activities which support or control manned base and platform on-orbit operations).

#### Utilization and Operations Planning

Before the "real-time" operations and support functions occur, there must be an operations and utilization planning process for determining policies and procedures for allocation of resources, selection of users, and systems evolution. NASA and its partners will meet routinely to assess whether the Program is meeting its broad goals and objectives, and to make long term plans with regard to utilization of the Station and potential addition of new capabilities. Users and Program officials will meet regularly to develop manifests (a schedule of when user payloads will be launched or returned from one of the orbiting spacecraft). Manifesting procedures will include both a "standard" cycle and a so-called "quick is beautiful"

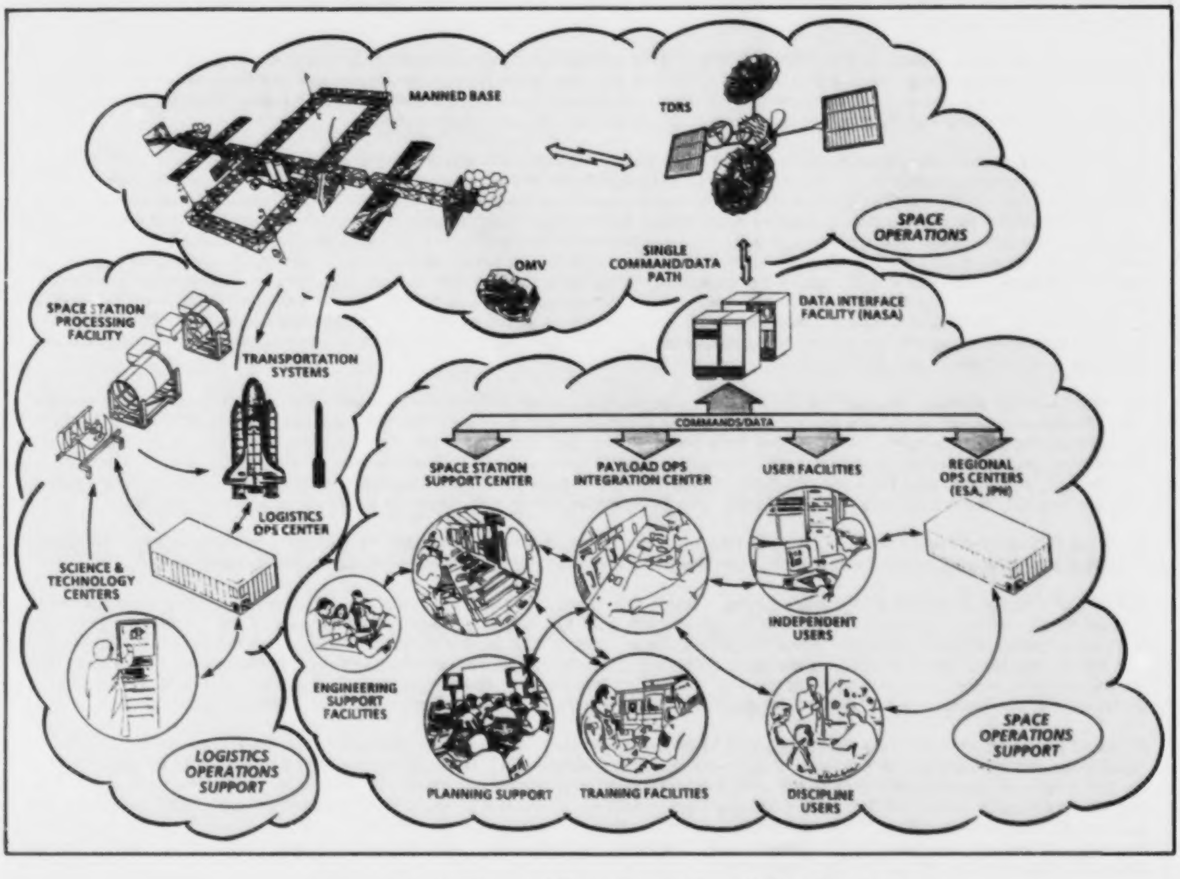
MANNED BASE
TDRS
SPACE OPERATIONS
SINGLE COMMAND/DATA PATH
OMV
DATA INTERFACE FACILITY (NASA)
SPACE STATION PROCESSING FACILITY
TRANSPORTATION SYSTEMS
COMMANDS/DATA
SPACE STATION SUPPORT CENTER
PAYLOAD OPS INTEGRATION CENTER
USER FACILITIES
REGIONAL OPS CENTERS (ESA, JPN)
LOGISTICS OPS CENTER
SCIENCE & TECHNOLOGY CENTERS
INDEPENDENT USERS
ENGINEERING SUPPORT FACILITIES
LOGISTICS OPERATIONS SUPPORT
PLANNING SUPPORT
TRAINING FACILITIES
DISCIPLINE USERS
SPACE OPERATIONS SUPPORT

Figure II-2 Manned Base Operations Infrastructure

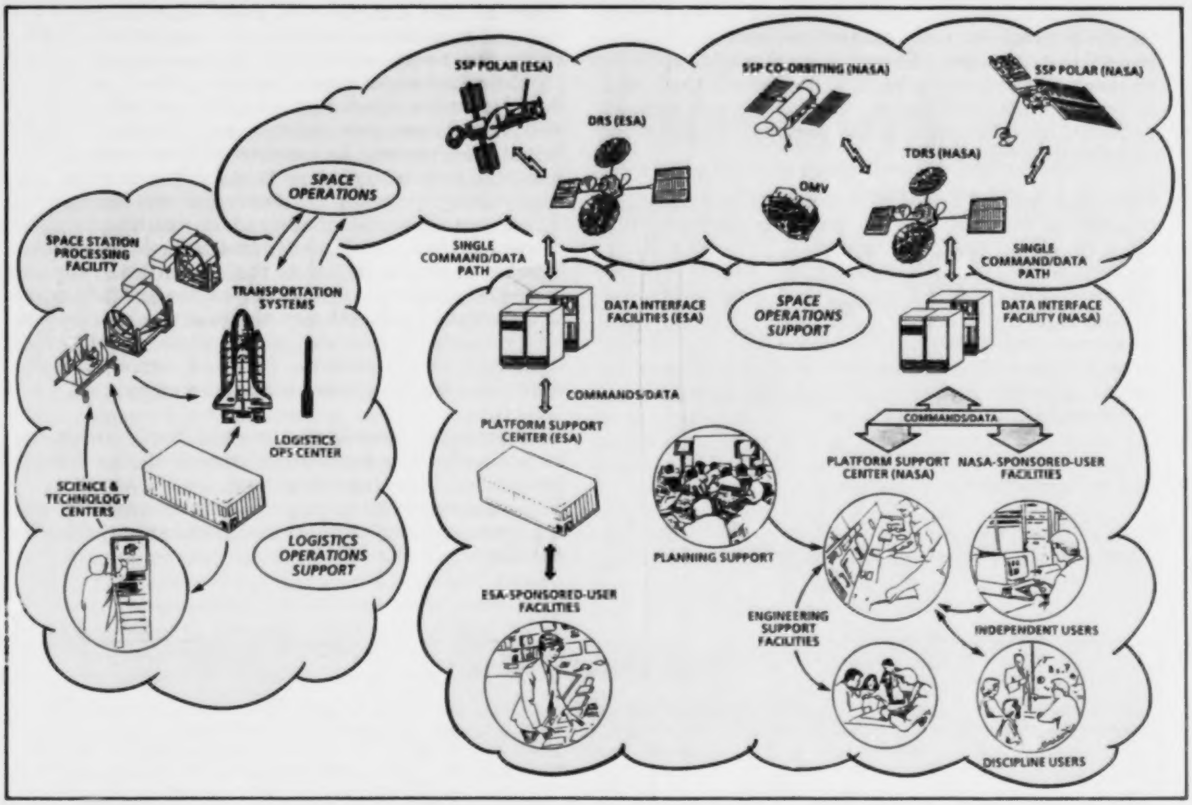
SSP POLAR (ESA)
DRS (ESA)
SSP CO-ORBITING (NASA)
SSP POLAR (NASA)
TDRS (NASA)
OMV
SPACE OPERATIONS
SPACE STATION PROCESSING FACILITY
TRANSPORTATION SYSTEMS
SINGLE COMMAND/DATA PATH
DATA INTERFACE FACILITIES (ESA)
SPACE OPERATIONS SUPPORT
SINGLE COMMAND/DATA PATH
DATA INTERFACE FACILITY (NASA)
COMMANDS/DATA
PLATFORM SUPPORT CENTER (ESA)
COMMANDS/DATA
PLATFORM SUPPORT CENTER (NASA)
NASA-SPONSORED-USER FACILITIES
LOGISTICS OPS CENTER
SCIENCE & TECHNOLOGY CENTERS
LOGISTICS OPERATIONS SUPPORT
PLANNING SUPPORT
ESA-SPONSORED-USER FACILITIES
ENGINEERING SUPPORT FACILITIES
INDEPENDENT USERS
DISCIPLINE USERS

**Figure II-3 Platform Operations Infrastructure**

cycle. The standard cycle will cover the allocation of payload resources, proposal and selection of payloads, performance of engineering analyses, assignment of the payload to a particular Station element and flight "increment",[10] and development of successively more detailed timelines for managing the payloads on orbit. It is anticipated that a certain percentage of the Program's capabilities will be reserved for so-called "quick is beautiful" payloads. These are payloads which need expeditious launch to respond to a unique research opportunity (e.g., the appearance of a supernova), or to allow researchers to operate payloads which require a minimum of time to develop from the design phase to flight with a minimum of resources, and hence can be accommodated late in the manifesting process.

The user community screens candidate payloads and makes the final selection of specific payloads to be placed on the Station manifest. As researchers in the U.S. and abroad develop and build instruments and payloads, they will be supported by Program documentation and personnel to ensure their payloads comply with Program requirements. This support is provided by the Program at the user's location, the launch sites, and at geographically dispersed Science and Technology Centers.[11] The Science and Technology Centers will conduct payload to rack integration, and perform functional operations verification of the payloads. Staff from the Office of Safety, Reliability, Maintainability & Quality Assurance will conduct regular independent reviews to ensure that safety and quality standards are met.

## Logistics Operations Support

For U.S. launches, integration of flight hardware resupply and maintenance activities will be conducted by a single Logistics Operations Center (LOC) located at the launch site. Payload racks and payload interface adapters (PIAs--for external payloads) which have been integrated at Science and Technology Centers, "stand-alone" payloads, and logistics material will be delivered to a Space Station Processing Facility (SSPF) for final checkout and integration into the STS or expendable boosters. Reusable equipment, such as payload equipment racks, will be refurbished and maintained between flights. Similar launch support activities may also occur at the partners' launch sites, coordinated by the LOC.

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[10] *A Space Station increment is defined as the length of time which transpires between STS visits. This term applies to both the manned base and the platforms (although platform increments can be much longer than those for the manned base).*

[11] *The Science and Technology Centers may be located at NASA, partner, or user sites. These Centers are certified by the Program as complying with Program and STS safety, interface, and operations requirements.*

The Space Station Program will maintain continuous interaction with the Shuttle program (and possibly other space transportation systems). The Shuttle is integral to Station deployment and operations; it is the gateway through which system and user hardware, Station logistics, and crew must pass.[12] Hence, to the maximum extent feasible, the schedules and procedures for the two programs must be closely aligned to avoid duplication of effort and to optimize the efficiency of the entire space infrastructure.[13]

### Space Operations

The "productive activity" will take place in orbit. An international team of astronauts will monitor and report on approximately 100 major experiments in the manned base's labs, resource nodes and attached to its truss. Some may participate in human biomedical and physiological experiments involving blood and tissue samples and/or special exercises or motions. Others will tend laboratory animals and plants. Payload Scientists sponsored by commercial firms may engage in highly proprietary research in fields such as genetic engineering or advanced semiconductor deposition techniques. Scientists may conduct live broadcasts of space research, working in real-time with ground-based researchers, or explain their activities in any one of several languages to students on the ground. Some of the experiments onboard the manned base will be proprietary, requiring some form of physical separation of experiments, data and communications channels, and provision of dedicated crew support.

User activities outside the manned base will utilize both telerobotic and astronaut extra-vehicular activity for payload servicing, changeout, or the assembly of large structures and spacecraft. Often the activity will require a combination of both intra and extra-vehicular activities (IVA and EVA).

**SPACE STATION AUTOMATION**

*Automation of Space Station systems both on the ground and onboard, and the use of robotic hardware to relieve crews of tedious and/or dangerous tasks, should be a central aspect of the Space Station design studies. Decisions must be made as soon as possible on which systems are to be automated on the initial Station, on which robotic technologies are required early, and on the hooks and scars which must be added to the initial Station design to allow the addition of further automation and robotics (A&R) during evolutionary phases of the Program. In order to facilitate such decisions, the Phase C/D design efforts must include studies of A&R systems from an operational and life cycle cost basis. At the very least, the initial Station must provide the systems required to acquire the "knowledge base" necessary to build automation capability as the Station evolves.*

*In making these statements, the Task Force concurs with the conclusions of the Advanced Technology Advisory Committee (ATAC), which completed its report of automation and robotics applications on the Space Station in April 1985. These conclusions were:*

- *Automation and robotics should be a significant element of the Space Station Program.*
- *The initial Space Station should be designed to accommodate evolution and growth in automation and robotics.*
- *The initial Space Station should utilize significant elements of automation and robotics technology.*
- *Criteria for the incorporation of A&R technology should be developed and promulgated.*
- *Verification of the performance of automated equipment should be stressed, including terrestrial and space demonstrations to validate technology for Space Station use.*
- *Maximum use should be made of technology developed for industry and Government.*
- *The techniques of automation should be used to enhance NASA's management capability.*
- *NASA should provide the measures and assessments to verify the inclusion of automation and robotics in the Space Station.*
- *The initial Space Station should utilize as much automation and robotics technology as time and resources permit.*
- *An evolutionary station should achieve, in stages, a very high level of advanced automation.*
- *An aggressive program of long-range technology advancement should be pursued, recognizing areas in which NASA must lead, provide leverage for, or exploit developments.*
- *A vigorous program of technology transfer to U.S. industries and research and development communities should be pursued.*
- *Satellites and their payloads accessible from the Space Station should be designed, as far as possible, to be serviced and repaired by robots.*

*While acknowledging the great potential of A&R in the Space Station Program, the Task Force cautions that increased Station automation should be treated not as an end in itself, but only as a means to relieve the onboard crew of tedious, repetitive or dangerous tasks and/or as a means of decreasing Station operating costs.*

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[12] *The SSOTF assumed that the NASA Space Transportation System (STS) will serve as the primary transportation system in support of the Station. The Shuttle and Station systems were assumed to be intimately interconnected, with substantial synergy in operations. However, the SSOTF was instructed not to preclude the use of other transportation vehicles (e.g., expendable launchers), and to evaluate whether or how such systems would improve the operational efficiency of the Station. It was also assumed that other manned space vehicles could be used in conjunction with the Station as long as those vehicles were made to be compatible with Station interfaces and procedures.*

[13] *In a traditional NASA mission (e.g., launch of an interplanetary spacecraft), the technical interface needs to be defined only once, the payload needs only one manifest, and once the spacecraft is deployed, there is little, if any, continuing interaction. STS/Station interfaces are considered as a special topic in Section IV.E.*

In addition to performing user activities, the crew of the manned base will have responsibilities for the operation, maintenance, repair and upgrade of many core systems. This would include: examination of the external structure using the MSC and the closed circuit television (CCTV) system; command and control of unmanned free-flyers in the manned base's command and control zone (within 20 nm); routine maintenance on internal systems such as power, ECLS, data management and communications; and operation of the manned base's attitude control and guidance systems. EVA activities will include repair and maintenance of external components, support for Shuttle logistics resupply, and servicing and repair of external payloads, the co-orbiting platform and other spacecraft.

The crew of eight astronauts will normally be split into two teams working alternating twelve-hour shifts. (Each shift will include nine hours of work and three hours of on-call time.) Normal work will be scheduled for six days per week. The crew rotation cycle is likely to be variable dependent upon tasks to be performed during a given increment and STS support constraints, but it is expected that half the crew will be changed out with each Shuttle visit. Crews will include career astronauts (employed by the SSP) as well as non-career astronauts supplied by users. Crew skills will be based on Station requirements and are likely to differ from STS skills, since some pilot skills will not be required for the Station.

The crew will conduct activities both inside (IVA) and outside (EVA) of the manned base. Career astronauts will perform all of the manned base systems operations, all EVA operations, and will support users. Non-career astronauts will be flown when unique payloads require them. However, non-career astronauts will also be required to support other users, since crew time will be a scarce resource and there will be many payloads requiring support.

### Space Operations Support

Space operations support facilities will support onboard crew and manned base systems by performing those functions which can most effectively be conducted on the ground. In effect, while logistics support covers the transportation of all physical material to and from orbit, space operations support covers the preparation and "transport" of system and user commands and data to and from the Station using data relay satellites.[14]

A Space Station Support Center (SSSC) will monitor the manned base's systems status, and relay commands to support the operations and ensure that safety requirements are met. Expert systems and other advanced computer technologies will be developed to support efficient Station operations. These systems will proliferate as the Station evolves, reflecting both continued advances in the capabilities of such systems, and greater understanding of the performance of manned base systems (which will result in the expansion of automated support to routine crew operations and support of time- critical events).

A Payload Operations Integration Center (POIC) will support the activities of the user community in integrating payload operations into the manned base. Users will work with Program personnel whose function is to guide the user through the detailed process of developing compatible payloads according to Program specifications. Experiment and payload development will occur at a variety of user facilities throughout the world, but payload operations for the manned base will be coordinated by the POIC.

Users will have a great deal of flexibility in organizing for their own operations. They may work out of their existing facilities, or may group together on a regional or disciplinary basis to share facilities and resources. Those users wishing to conduct proprietary operations will have the ability to encrypt their data, subject to minimal Program safety oversight. Many users will operate in a "telescience" mode, directly interacting with their experiments using the Program's RF links and networking capabilities.

A Platform Support Center (PSC) will combine the system and user support functions for the unmanned platforms. The PSC will have authority for all command and control functions for the platforms, except when they are in proximity to the manned base or the STS. The PSC contains two functional operations centers. These are the Platform Payload Operations Center (PPOC) and the Platform Transfer Operations Center (PTOC). The PPOC performs both systems control and user coordination functions (analogous to the SSSC and the POIC roles). The PTOC is a unique function associated with preparing and conducting servicing operations on the platforms. The period of time during which the platform is taken "out of service" for these operations is called Transfer Operations.

A number of Engineering Support Centers (ESCs) will support the SSSC and PSC. These will initially be synonymous with the program's hardware development centers in the U.S. and abroad. The ESCs will be the repository of information on the technical characteristics of the flight hardware. The ESCs will support anomaly resolution and provide operations analyses related to their areas of expertise.

The Program will also coordinate and manage simulation and training facilities for the manned base crew, ground-based support personnel and Station users. These facilities will provide the "off-line" education in Station and selected payload systems which must be learned prior to actual space operations.

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[14] *The manned base will be linked to the ground through the Tracking and Data Relay Satellite System (TDRSS). The U.S. platforms will also be linked to the ground via the TDRSS; European (and possibly Japanese platforms at a later date) may be linked through European or Japanese data relay satellites.*

## II.C. CHARACTERIZING THE USER COMMUNITY

Space Station operations will be heavily influenced by the user community. Hence, it is necessary to characterize the utilization parameters for Station services in order to understand how Station operations should be structured. (See Table II-2.)

### II.C.1. Demographic Categorization of Users

Traditionally, NASA customers have been grouped by sponsor. In this manner users can be easily distinguished in terms of their broad goals, means of support, and overall priority for access to NASA facilities or services. Dividing the Space Station user community along such demographic lines results in the following general groupings:

**NASA Researchers**

This group encompasses the traditional NASA space research community sponsored by the various internal NASA program offices (Office of Space Science and Applications, Office of Aeronautics and Space Technology). Research activities are conducted under NASA auspices and paid for through the NASA budgetary process.

**NOAA**

The National Oceanographic and Atmospheric Administration has worked very closely with NASA in the areas of meteorology and earth observations. Until recently, NASA has traditionally been the developer or procurement agent for NOAA's weather and earth resources satellites, which are turned over to NOAA once they have been launched and completed on-orbit checkout. Operations are funded through the Department of Commerce.

**Academic/Science Users**

This group consists of users sponsored by academic or other non-profit research institutions (or individuals). Historically, there have been few independent academic users. Most have operated under NASA support. However, the potential for greater independent academic involvement in space will exist once the Space Station enters its Mature Operations Phase.

**Department of Defense**

DOD utilization of the Station could have significant operational impacts which need to be clearly defined and anticipated. The most significant issue to be resolved is the potential requirement for highly secure DOD operations, and the impact of this requirement on

| DEMOGRAPHIC SPACE STATION USER GROUPS | DISCIPLINE SPACE STATION USER GROUPS | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | MATERIALS SCIENCE RESEARCH | LIFE SCIENCE RESEARCH | SERVICING AND ASSEMBLY | TECHNOLOGY DEVELOPMENT | EARTH OBSERVATION | ASTRO/SOLAR PLANETARY OBSERVATIONS | ASTRO/SOLAR PLANETARY PHYSICS | COMMERCIAL PRODUCTION | COMM. |
| NASA | X | X | X | X | X | X | X | | X |
| NOAA | | | | X | X | | | | |
| ACADEMIC & SCIENCE | X | X | | X | X | X | X | | |
| DOD | X | X | X | X | X | | | | X |
| COMMERCIAL | X | | X | X | X | | | X | X |
| INTERNATIONAL | X | X | X | X | X | X | X | X | X |
| OTHER U.S. GOVERNMENT AGENCIES | X | X | | X | X | | | | |

Table II-2 Characterizing The User Community

non-classified users. At present, the DOD has not defined any operational uses for the Station, but has stated its interest in using the Station to support proprietary research activities.

The SSOTF assumed that the Space Station is a civilian program, in which all operations will be consistent with the NASA charter and existing international agreements to which the United States is a party. No unique military requirements were considered in selecting alternatives to the framework. DOD was treated as a potential user whose requirements were equivalent to those of any other proprietary user.

### Commercial Users

This group is composed of private firms which plan to conduct research and development, and/or perform pilot production activities taking advantage of the characteristics of the space environment. These users are much more sensitive to scheduling and proprietary operations considerations, since they must meet financial and competitive business goals of the marketplace. In comparison to the traditional space research community, many of these users have a low level of space experience, and require support in formulating their space activities and meeting NASA procedural requirements.

The SSOTF did not address privatization or commercial provision of Station operations services explicitly, but did not preclude private sector participation in the operations framework. In the framework developed by the SSOTF, it is assumed that all Station elements are operated by the partners with NASA in a lead role, but the framework does not preclude the option to transition some activities to the private sector.

### International Users

ESA, Japan and Canada plan to sponsor users from their own space agencies, other government facilities, private industry, and academia. These users generally share the resource requirements identified for the corresponding category of U.S. users. However, they pose additional operational demands based on policy issues (e.g., technology transfer, different national legal codes), and require additional logistical interfaces to accommodate their needs.

Users may also come from nations which are not Space Station partners. However, these users will have to be sponsored by one of the Space Station partners, and their resource requirements will be drawn from the sponsor's allotment.

### Other U.S. Government Agencies

In addition to NOAA and the DOD, a number of other government agencies are expected to become users of the Station in the future. The area of greatest early interest lies in earth observing missions. Landsat data has already been extensively utilized by the Department of Agriculture, and other uses in the fields of material and life sciences and technology development are expected to be pursued by various government agencies.

## II.C.2. Disciplinary Categorization of Users

Users must also be categorized by discipline in order to evaluate technical requirements. (See again Table II-2.) Classifying users in this manner provides the following breakdown.

### Materials Science

Materials science is one of the most promising fields planned for the Space Station's facilities, and includes users from all the demographic categories except NOAA. The field encompasses research and pilot production activities, including: (1) biological, organic and pharmaceutical substances; (2) inorganic crystals; (3) advanced glasses and ceramics; (4) metals and alloys; (5) combustion technologies; and (6) polymer chemistry.

Microgravity science users often have significant power requirements and need access to a high-quality microgravity environment, but are insensitive to other operational characteristics such as pointing orientation. Most of these activities can be conducted best through the use of an orbiting laboratory facility with man in-the-loop.

### Life Sciences

The study of microgravity effects on living organisms (including man) is a second area of growing interest. This interest is focused in three directions: understanding subtle physiological processes which are masked by gravity; research into phenomena such as Space Adaptation Syndrome and osteoporosis, which provides insight into maladies present on Earth; and research into the long term effects of weightlessness (a prerequisite to long duration manned flights). Such activities are currently of primary interest to NASA, the partner governments, and to the academic community. DOD and private sector interest may grow as the capabilities of the manned base become more apparent. Such activities typically require a high level of manned interaction in a laboratory environment. It is anticipated that such life science research will receive a high priority during the early days of the Program to support the extension of crew stay time on-orbit up to 180 days and beyond for Station missions, and in preparation for supporting manned lunar and planetary exploration.

### Servicing and Assembly

All user communities have expressed interest in satellite and attached payload servicing and assembly capabilities which would extend satellite or other payload lifetimes, reduce mission costs, or allow the on-orbit assembly of structures too large to be deployed in a single launch. Since the experience level for such activities is still quite rudimentary, it is expected that government users will pace the development of this activity. These activities call for provision of a man-supported facility which can act as a base for on-orbit operations and infrastructure support.

### Technology Development

Technology development is a broad category that cuts across many disciplines and includes the development and demonstration of advanced space technologies such as robotics systems and solar dynamic power systems. Successful missions raise the "technology baseline" for new programs. For example, experiments with more powerful, compact batteries pave the way for their incorporation into new, more capable (or less costly) spacecraft. The majority of missions in this area would be conducted by NASA, the partners' space agencies, and the DOD. Technology development missions would utilize the full range of manned and unmanned Station assets.

### Earth Observations

The field of earth observations consists of activities related to the study of the structure and resources of the earth and its environment. Activities in this category demand high pointing accuracy and low-disturbance, and are best performed on unmanned platforms (usually in polar orbits). All of the demographic user groups are represented here.

### Astronomy, Astrophysics & Planetary Physics

The Space Station will support space observational sciences, including astronomy and astrophysics, and planetary physics and exploration. The use of man for experiment support, while often useful, is not usually critical (although some planetary physics experiments require manned support). Most of the users in this category will come from NASA and the partners' space agencies, and the academic community, and will conduct most of their activities using attached payloads or unmanned platforms.

### Commercial Production

Private firms may also engage in pilot production of materials in space. This industrial activity may generate much greater resource demands and will require a higher quality microgravity environment than smaller-scale research and development experiments. As a result, commercial production will usually require a dedicated platform catering to the specific needs of the commercial user. At present, it is not evident whether the best approach is to utilize unmanned or man-tended platforms.

### Communications

The Station will also serve as a base for advanced telecommunications and data transmission projects. Outside of technology development missions, the Space Station is not expected to play a primary role in space communications activity.

## II.C.3. User Requirements

Technical requirements of Space Station users have been addressed in a number of previous studies, which have been instrumental in the definition of the current Station configuration and are summarized in the Space Station Mission Requirements Data Base. Based on these studies, the Station's capabilities can be defined in terms of specific resources which support user requirements. These capabilities are identified in Table II-3. Table II-4 lists those resources that have been identified as drivers from previous customer accommodation analyses, presented in order of priority to each user group. In this way, key Station capabilities can be identified based on the commonality of the requirements across user groups.

Procedural requirements reflect the preference of the user to maintain space operations under conditions similar to those used on Earth. Given the demographic diversity of users, it will not be possible to accomplish this goal completely, but it must be kept in mind in developing the user integration process (i.e., the processes and procedures that the user and the Station Program must implement to carry the payload through completion on the Station complex).

Although different procedural requirements will be more important to some groups than to others, a number of common requirements can be identified:

- User control of payload selection and resource allocation;
- A single point of contact within the Space Station program to which the user can turn for guidance in dealing with the various interfaces at each organizational level of the Program;
- Simple, standardized interface and integration procedures;
- Concise, accurate, and current documentation and documentation requirements, and easy access to information;
- Options ranging from nearly complete autonomy of user payload operation to complete user reliance on Station services;
- Clearly defined, consistent and reasonable standards in hardware, software, safety and services;
- Strict adherence to schedules and timelines, wherever possible;
- Flexibility in access to facilities in supporting user "windows of opportunity"; and
- User representation in decisions affecting the operation and viability of his payload.

While the above requirements are important to all users, some user groups will generate unique requirements. The most important of these are:

| | | |
|---|---|---|
| **ELECTRIC POWER**<br>GENERATION LEVEL<br>STORAGE (PEAK)<br>MANAGEMENT & CONDITIONING | **MANNED INTERVENTION**<br>EVA<br>IVA<br>REMOTE MANIPULATORS<br>AUTOMATION | **OPERATIONS/PROTOCOL**<br>SCHEDULED ACCESS<br>EVENT-DRIVEN PRIORITY<br>DEDICATED PERSONNEL |
| **EXTERNAL ENVIRONMENT**<br>HIGH VACUUM/LOW CONTAMINATION<br>RADIATION SHIELDING | **CORE UTILITIES**<br>DATA MANAGEMENT (DMS)<br>COMMUNICATIONS<br>FLUID MANAGEMENT<br>THERMAL MANAGEMENT | **ON-ORBIT SERVICING**<br>FREE-FLYERS<br>SPACECRAFT/VEHICLES<br>ASSEMBLY |
| **GRAVITY LEVEL**<br>MICROGRAVITY (AMBIENT)<br>VARIABLE GRAVITY | **ACCESS TO PLATFORMS**<br>CO-ORBITAL<br>POLAR | **RESEARCH SECURITY**<br>DATA<br>HARDWARE |
| **INTERNAL ENVIRONMENT**<br>PRESSURIZED VOLUME<br>SPECIAL ENVIRONMENT<br>HAZARDOUS MATERIALS | **ACCESS TO ATTACHED PAYLOADS**<br>EARTH OBSERVATION<br>ASTRONOMICAL OBSERVATION<br>UNPRESSURIZED ATTACHMENT<br>PRESSURIZED ATTACHMENT | **LOGISTICS**<br>VOLUME/MASS<br>RESUPPLY INTERVAL<br>ON-ORBIT STORAGE<br>WASTE MANAGEMENT<br>OVERSIZED PAYLOADS |

Table II-3 Space Station Capabilities For Users

| MATERIALS SCIENCE | LIFE SCIENCE | SERVICING & ASSEMBLY | OBSERVATIONAL (EARTH & ASTRO) | PHYSICAL & PLANETARY SCIENCE | COMMERCIAL PILOT PRODUCTION |
|---|---|---|---|---|---|
| Electric power | Pressurized volume | EVA-crew time | Communications System | Access to surge/pulse electric power | Electric power |
| High quality micro-g | Special pressurized environments | Access to remote manipulators | Access to polar platform | IVA-crew time | High quality micro-g |
| IVA-crew time | IVA-crew time | Fluid management system | Servicing for platforms | Pressurized volume | Pressurized volume |
| Thermal management system | Waste management system | Platform and spacecraft servicing | Event-driven priority access to resources | Special pressurized environments | IVA-crew time |
| Pressurized volume | Large volume logistics support | IVA-crew time | Electric power | Power management and conditioning | Need for scheduled access |
| Hazardous materials handling | Electric power | Large structures assembly and support | Access to attached payload space | Variable gravity levels | Fluid, thermal and waste management systems |
| Data management system | Variable gravity levels | Communications system | High quality vacuum environment | Thermal management system | Large volume logistics support |

Table II-4 Prioritized Capabilities By User Discipline

- Availability of rapid-response payload accommodation procedures ("quick is beautiful"): Some users, such as commercial firms wishing to take advantage of a proprietary opportunity, or government researchers pursuing an unexpected or unique scientific window of opportunity, will desire rapid access to Station facilities.

- Proprietary operations support: Commercial firms and the DOD will require unique operational procedures for the protection of proprietary activities. Proprietary requirements will affect crew operations, ground and onboard handling of user and Station communications and data management, and the prelaunch/postlanding processing approach to the payload.

- Late pad access, early return capability, and rapid post-landing access: Many experiments, notably those in life sciences, will require "last-minute" access to payloads on the launch pad. Likewise, many experimenters may wish to quickly return experiment samples which have behaved in unanticipated ways for earth-based analysis. Finally, many payloads (again, life sciences are a notable example) may require early deintegration from the STS upon return from space.

The SSOTF had to incorporate such specialized procedural requirements into the design for the operations framework, along with the more traditional technical user requirements. Together with the definition of the key user groups and their broad facilities requirements, these technical and procedural requirements form the baseline for defining an operations framework.

# III. SPACE STATION OPERATIONS

This chapter presents the Recommended Framework for Space Station operations. The core of the Task Force effort, the Framework lays out the management and organizational approach which the Task Force believes best meets the Program objectives outlined in Chapter II. Section III.A provides a brief synopsis of the operations functions which must be performed to meet Program objectives, and presents the operations evaluation criteria which the Task Force used to select among various framework options to perform the functions. The introduction section (III.B.1) presents the management approach for the Framework and synopsizes major themes; the following subsections provide the details of the Framework for the manned base and the unmanned platforms respectively.[1] Section III.C develops the organizational structure (including assignment of roles and responsibilities) which the SSOTF recommends for implementing the Recommended Framework. Section III.D summarizes a User Integration Scenario which the Task Force performed as a "sanity check" on the Framework to insure that it adequately met users' needs, and to illustrate the functioning of the Framework in real life.[2]

## III.A. OPERATIONS FUNCTIONS

An operations function is a task or set of tasks required to sustain space operations.[3] In the broadest of definitions, any activity associated with operations can be considered an operations function (for example, Congressional approval of the NASA operations budget). The Task Force, however, defined operations functions in a more restrictive sense: those activities performed by the SSP and users which (1) keep the Station elements (both ground and space-based) in working condition; and (2) support productive utilization of Program assets.

The Task Force consensus was that the Space Station Program did not involve any completely new operations functions other than regularly scheduled resupply and changeout of user payloads. While Space Station is complex (both in "quantitative" terms relating to its size, and "qualitative" terms relating to its multiple uses), previous NASA missions have already mapped out similar operations functions.[4] What is different is how NASA and its partners must organize to perform those functions, and the greater degree of flexibility which the operations framework must incorporate to meet its diverse and changing day-to-day tasks. Likewise, the Program's operations framework must embody a life cycle cost orientation consistent with its long mission.

### III.A.1. Operations Functions Categories

Space Station operations functions can be defined in terms of categories of activity (related subfunctions). These categories are presented in Figure III-1. They fall naturally into three areas: Operations Oversight, Program Operations and User Operations.[5] The Safety, Reliability, Maintainability and Quality Assurance (SRM&QA) function is interwoven in both user and systems operations.[6]

### Operations Oversight

NASA and its partners will need to establish, monitor and revise overall Program policies as required for Space Station operations. These functions establish Program-wide objectives and assignment of roles and responsibilities for the partners. Many of these activities, such as budget planning and program performance and cost assessments, will be continuous in nature. Others, such as specific international nego-

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[1] *With the exception of unique activities necessary to support man's presence in space, the operations functions necessary to conduct manned base and platform operations are essentially the same. However, there are differences in the way the functions are performed and in the frequency of performance. These differences led to the development of separate recommendations for the management, planning, and execution of manned base and platform operations.*

[2] *Further details on the Recommended Framework can be found in the various Panel reports.*

[3] *This definition separates activities involved in design, development, test and engineering (DDT&E) from operations. Phase C development efforts are not operations functions. However, the dividing line between DDT&E and operations can be very fine. For example, while building an additional module for the manned base would not be an operations function, activities associated with defining the requirements for the new module, approving its inclusion in the Program, engineering and operations assessments of the impact of the new module on the existing configuration, and manifesting the launch and integration of the new module, would be operations functions.*

[4] *The operations functions which will be required for the manned base have already been performed in the manned space flight program (especially in the Skylab, STS and Spacelab programs); platform operations are similar to previous unmanned missions.*

[5] *This chapter presents general descriptions of operations functions. Detailed "input-output" functional flows are provided in Appendix B. The Task Force focused its effort on those functions which "reside" in the Space Station Program, and dealt with user functions only to the extent of defining the interface requirements from the Program's perspective. The Task Force felt that the development of user roles, responsibilities and organization are best addressed by the users themselves. Note as well that these are operations functions only; requirements associated with hardware development (DDT&E) are included only to the extent that they affect ongoing operations.*

[6] *SRM&QA is the responsibility of users and Program personnel at all levels of planning and activity. Likewise, an independent "watchdog" (i.e., non-SSP) safety office will monitor users and Program personnel. (See Section III.C.2 for a presentation of SSP relationships with the SRM&QA office.) Hence, this function is listed separate from User and Program operations. The importance of this independent function in NASA has been institutionalized in the Office of Safety, Reliability, Maintainability and Quality Assurance at NASA Headquarters.*

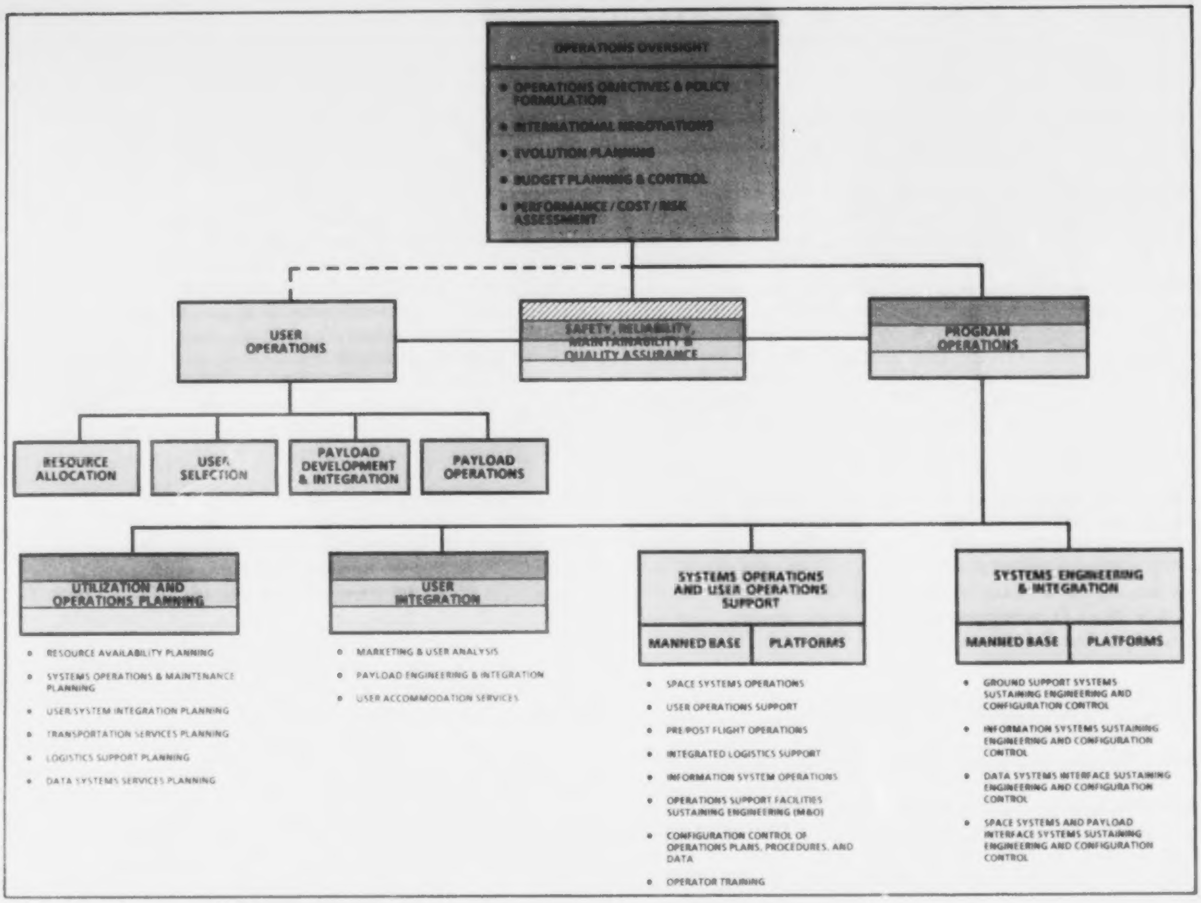
OPERATIONS OVERSIGHT
• OPERATIONS OBJECTIVES & POLICY FORMULATION
• INTERNATIONAL NEGOTIATIONS
• EVOLUTION PLANNING
• BUDGET PLANNING & CONTROL
• PERFORMANCE / COST / RISK ASSESSMENT
USER OPERATIONS
SAFETY, RELIABILITY, MAINTAINABILITY & QUALITY ASSURANCE
PROGRAM OPERATIONS
RESOURCE ALLOCATION
USER SELECTION
PAYLOAD DEVELOPMENT & INTEGRATION
PAYLOAD OPERATIONS
UTILIZATION AND OPERATIONS PLANNING
• RESOURCE AVAILABILITY PLANNING
• SYSTEMS OPERATIONS & MAINTENANCE PLANNING
• USER/SYSTEM INTEGRATION PLANNING
• TRANSPORTATION SERVICES PLANNING
• LOGISTICS SUPPORT PLANNING
• DATA SYSTEMS SERVICES PLANNING
USER INTEGRATION
• MARKETING & USER ANALYSIS
• PAYLOAD ENGINEERING & INTEGRATION
• USER ACCOMMODATION SERVICES
SYSTEMS OPERATIONS AND USER OPERATIONS SUPPORT
MANNED BASE
PLATFORMS
• SPACE SYSTEMS OPERATIONS
• USER OPERATIONS SUPPORT
• PRE/POST FLIGHT OPERATIONS
• INTEGRATED LOGISTICS SUPPORT
• INFORMATION SYSTEM OPERATIONS
• OPERATIONS SUPPORT FACILITIES SUSTAINING ENGINEERING (M&O)
• CONFIGURATION CONTROL OF OPERATIONS PLANS, PROCEDURES, AND DATA
• OPERATOR TRAINING
SYSTEMS ENGINEERING & INTEGRATION
MANNED BASE
PLATFORMS
• GROUND SUPPORT SYSTEMS SUSTAINING ENGINEERING AND CONFIGURATION CONTROL
• INFORMATION SYSTEMS SUSTAINING ENGINEERING AND CONFIGURATION CONTROL
• DATA SYSTEMS INTERFACE SUSTAINING ENGINEERING AND CONFIGURATION CONTROL
• SPACE SYSTEMS AND PAYLOAD INTERFACE SYSTEMS SUSTAINING ENGINEERING AND CONFIGURATION CONTROL

Figure III-1 Operations Functions

tiations or evolution planning will be "requirement-driven" and occur on a less frequent basis. These functions apply to the broad conduct of both user and SSP operations, and hence serve as the strategic frame within which all activities occur. Operations control functions also include the activities which monitor the overall resources for the Program. Budgets must be established for specific activities, and Program expenditures must be monitored and controlled in order to ensure that funding achieves desired objectives in an efficient manner.

### User Operations

User Operations are broken into four subcategories: Resource Allocation; User Selection; Payload Development and Integration; and Payload Operations. These categories have a temporal relationship for an individual user: from the announcement of a flight opportunity to the performance of an experiment. From the Program perspective, all of the functions will be performed concurrently, as multiple users "work their way through the system."

Resource Allocation: Resource allocation includes all of the tasks for determining how the Station's available resources will be distributed among different user groups. Allocations will be made among the partners at a "national" level by MOUs, and are thus a function of the Program. However, the subsequent distribution of the partner resource shares to differing user groups will be a function conducted by the users. The SSOTF judged that the users were in the best position to evaluate the merit of which activities should be performed.

User Selection: The user selection process consists of all of the user tasks performed by the sponsoring organizations for deciding what payloads should be flown on the Station. User selection usually involves some form of peer review process. The Program then accepts those experiments that are consistent with ongoing and proposed activities by conducting engineering analyses which verify that a payload meets system and user safety requirements, and will not cause undue conflict with previously selected payloads or partner interests. Finally, the Program will work with users to put them into the manifest.

Payload Development and Integration: Payload development and integration includes definition, design, construction, and ground testing (functional verification) of the individual payload, integration of payloads to payload racks or Payload Interface Adapters (PIAs), and transport of the payload to the Space Station Program launch site(s). Program input will focus upon safety assurance and verification of rack-to-Station and PIA-to-Station interfaces. (All other tasks are the responsibility of the user.)

Payload Operations: Users can be expected to maintain ground control facilities for transmitting payload commands, receiving payload return data (telemetry), and for storing and analyzing data or products which are returned from the Station.[7] The capabilities of such User Operations Facilities (UOFs) shall be determined by the user community.[8]

**Program Operations**

Space Station Program Operations are grouped into four subcategories: Utilization and Operations Planning; User Integration; System Operations and User Operations Support; and Systems Engineering and Integration.

Utilization and Operations Planning: Utilization and Operations Planning is the end-to-end process for developing requirements and schedules for Space Station operations. Users will submit their list of candidate payloads; it will then be the responsibility of the Program to translate the user requirements into a proposed manifest. System support planning will be performed by the SSP: resupply of consumables, systems operations and maintenance schedules, and crew assignment are typical of these continuous planning activities. This function also incorporates the sequencing of systems upgrades into the Program's flight and ground elements (e.g., coordinating addition of a new module with ongoing experiments and crew skills). Planning functions will be closely integrated with Space Transportation System and non-SSP information systems (e.g., TDRSS) planning functions.

User Integration: User Integration is the process of assisting users in payload development. It includes any "user outreach" or "marketing" functions associated with encouraging prospective users to provide payloads; the assignment of a PAM to selected users;[9] engineering support to ensure that payload design conforms to Station configuration and safety specifications; and safety and interface testing and verification prior to launch and when the payload is installed on the Station.

Systems Operations and User Operations Support: Systems Operations and User Operations Support include all of the activities undertaken by Program personnel to support space operations on both the manned base and the platforms.[10] This includes all of the ground-based activity devoted to maintaining the Station elements in orbit (such as crew activity scheduling, procedures development, trajectory analysis, crew training, data systems operations, prelaunch and postlanding processing and logistics operations), space operations (crew, Station system and payload operations on orbit) and sustaining engineering (M&O related) for operations support facilities. This function also includes configuration control of Station utilization and operations plans, as well as definition of crew training requirements.

Systems Engineering and Integration: Systems Engineering and Integration (SE&I) encompasses the ongoing engineering analyses performed on hardware, software, and technical operations processes which are associated with sustaining the Station's space systems, their payload interfaces, and their interfacing ground systems (including information management systems) over the life of the Program. This includes the performance of technical feasibility studies, systems performance analyses, and production/operations costs trades relating to the proposed modifications as well as the preparation and dispensing of related engineering change requests. The SE&I function also includes the maintenance of Program configuration control for all baselined Station and interfacing ground support systems.

Guidance for SE&I activities would come primarily from operations oversight functions (which provide long-term system objectives) and operations and utilization planning and user integration functions (which generate near-term system change requirements). Feasibility and supportability analyses performed by the SE&I function would be used as inputs not only for engineering changes for ongoing operations, but also for advanced development efforts.

### III.A.2 Developing the Operations Framework

The SSOTF deliberated at length over the development of an overall operations management and control framework which best enabled the performance of these functions (and their related subfunctions) by the appropriate management levels of the operations organization (as depicted in Table III-1). As there were a number of framework options available which would appear to be at least feasible, the Task Force devised a set of option evaluation criteria which were in large part directly or indirectly correlatable to overall Program goals. Each option was evaluated, in a relative sense, on how well it satisfied these evaluation criteria and, hence, Station Program goals.[11] The six evaluation criteria chosen by the SSOTF address an option's ability to support and enhance: (1) Program control; (2) Program safety and system integrity; (3) effective user operations; (4) substantive international participation; (5) assembly and evolution; and (6) operations cost effectiveness.

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[7] *Command links between the ground and the flight elements shall be managed by the Program.*

[8] *Some users may wish to develop highly proprietary User Operations Facilities (UOFs). Others may wish to share common overhead costs within a single facility; these could be centers oriented towards a specific area of investigation, referred to as "Discipline Operations Centers" (DOCs); or geographically-focused Regional Operations Centers (ROCs). All user facilities must be designed and operated in accordance with Program safety requirements.*

[9] *The Framework recommends the assignment of a single point of contact for each user. This SSP representative is the "Payload Accommodation Manager," or "PAM."*

[10] *The SSOTF separated these functions for the manned base and platforms because of their different operational characteristics. Platforms will largely operate independently from the manned base.*

Program Control: The most fundamental criterion is whether or not the option is manageable; i.e., is it controllable and will it work? Any option for Station operations must be "codified" in a management structure which establishes proper levels for decision-making, accountability and control. Authority and chain of command must be clearly established so that any individual in the Program knows whom to turn to in both normal and off-nominal situations. This includes not only the establishment of hierarchical roles and responsibilities for Headquarters and Field Center operations organizations, but also a centralized management oversight function supported by a well-designed management information system.

Program Safety and System Integrity: Program safety and system integrity are of equal importance to Program Control. The value of the crew and the on-orbit hardware, and the long-term and continuous operations environment for the Program dictate that safety be considered a priority in the operations environment.[12] Hardware and software must be built to high reliability, redundancy and operability standards which are technically specific, measurable and predetermined. Standards of performance for crew

| PROGRAM POLICY FUNCTIONS | PROGRAM INTEGRATION FUNCTIONS | PROGRAM EXECUTION FUNCTIONS |
|---|---|---|
| 1. SPACE STATION PROGRAM OPERATIONS OBJECTIVES & POLICY FORMULATION | 1. INTEGRATED OPERATIONS PLANNING (SEPARATE FOR MANNED BASE 7 PLATFORMS EXCEPT FOR COP SERVICING)<br>1A. TACTICAL OPERATIONS PLANNING (MANNED BASE & PLATFORMS)<br>1B. MANNED BASE INCREMENT PLANNING (INCLUDES COP SERVICING) | 1. MANNED BASE SYSTEM OPERATIONS |
| 2. STRATEGIC UTILIZATION & OPERATIONS PLANNING | 2. USER INTEGRATION & ACCOMMODATION SERVICES | 2. MANNED BASE USER OPERATIONS SUPPORT |
| 3. INTERNATIONAL NEGOTIATIONS | 3. MANNED BASE & SUPPORT SYSTEM ENGINEERING & INTEGRATION | 3. PLATFORM(S) SYSTEM OPERATIONS |
| 4. EVOLUTION PLANNING | 4. PLATFORM & SUPPORT SYSTEMS ENGINEERING & INTEGRATION | 4. PLATFORM USER OPERATIONS SUPPORT |
| 5. SAFETY, RELIABILITY/ MAINTAINABILITY & QUALITY ASSURANCE | 5. INFORMATION & NETWORK SYSTEMS ENGINEERING & INTEGRATION | 5. PREFLIGHT/POSTFLIGHT OPERATIONS |
| 6. BUDGET PLANNING & CONTROL | 6. SAFETY, RELIABILITY/MAINTAINABILITY & QUALITY ASSURANCE | 6. INTEGRATED LOGISTICS OPERATIONS |
| 7. TRANSPORTATION SERVICES PLANNING | 7. BUDGET ADMINISTRATION & COST CONTROL | 7. INFORMATION SYSTEM OPERATIONS |
| 8. MARKETING & USER ANALYSIS | 8. INTEGRATED LOGISTICS SYSTEMS | 8. SUSTAINING ENGINEERING<br>8A. SPACE SYSTEMS<br>8B. GROUND SYSTEMS<br>8C. PAYLOAD INTERFACE ENGINEERING & INTEGRATION |
|  | 9. CONFIGURATION CONTROL (SPACE SYSTEMS, INTERFACING GROUND SYSTEMS, PAYLOAD INTERFACES, AND PROGRAM INTEGRATION-LEVEL OPERATIONS PLANS) | 9. CONFIGURATION MANAGEMENT<br>9A. SPACE SYSTEMS<br>9B. GROUND SYSTEMS<br>9C. PAYLOAD INTERFACES<br>9D. EXECUTION-LEVEL OPERATIONS PLANS & PROCEDURES (INCLUDING CONTROL) |
|  |  | 10. SAFETY, RELIABILITY/MAINTAINABILITY & QUALITY ASSURANCE |
|  |  | 11. OPERATOR TRAINING (CREW & GROUND PERSONNEL) |

**Table III-1 Space Station Program Key Operations Functions**

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[11] *Since it was impossible to provide a quantitative relationship among the program criteria, a hierarchy was established based on Task Force agreement that "A is more important than B." etc. The criteria were further defined within the context of specific operations functions as the Panels proposed and evaluated options.*

[12] *This presents a challenge to Space Station managers. The theoretical way to ensure safety is to develop extensive safety standards and operations constraints and to rigidly hold all Program operators and users to them. However, Program managers will face ever-present budgetary pressures, as well as the desires of users to "go where the research leads them" in real-time. Such pressures for operational flexibility must be tempered with sound management decisions regarding the waiving of these standards and constraints to fit individual situations.*

and ground personnel need to be established and their performance monitored. Safety also dictates that the Program's hardware systems and management structure incorporate "interlocks" which minimize and deter human and equipment error, alert operations managers when a malfunction has occurred, and minimize or isolate the effect of the error until it can be corrected. Finally, the Program operations structure must be capable of integrating outside safety reviews and oversight without causing undue burdens on ongoing system and user operations.

Effective User Operations: Once the basic management and safety requirements of the Program are met, the next most important evaluation criterion is whether the Space Station is "user-friendly." This means that the Program should be managed as a facility for users, compatible with their modes of operation. While the complexity of space operations will continue to dictate stringent safety requirements in all phases of user and system operations, it is generally acknowledged that the Program's "transparency" to users can be improved as compared with past programs. It is important to note that user-friendliness is a requirement for program management as well: the sheer volume of users necessitates a reliable and efficient means for selecting, preparing and flying them.[13]

An option is considered superior in terms of user orientation if it has a well understood and "simple" process for proposing, developing, integrating and operating payloads. It must be acceptable to the entire range of expected users. ("Acceptable" is a relative term, since different classes of users will have different requirements.) Some of the specific measures used in applying this criterion were: level of user participation in payload selection and utilization planning, the length of time required to take a user from initial contact to on-orbit operations, the number of interface points between the user and the Program, documentation requirements, complexity of integration standards, and the level of available user autonomy in operations.

Substantive International Participation: International participation as an evaluation criterion specifically addresses the desires of the partners to participate at all levels in the management and operation of the Program.[14] The SSOTF recognizes that specific roles and responsibilities have not yet been fully defined (this is the subject of ongoing negotiations); however, the Task Force noted that partners have an explicit desire to develop expertise in manned and unmanned space operations through their continuing involvement in the Program. Partner goals in the program are congruent, but not identical to, those of the United States. Specifically, the partners' desire to be given substantial operations responsibility through a decentralized management structure could, in some options, be in conflict with the safety and management effectiveness that comes from a "traditional" centralized NASA management structure.

As well, the Space Station operations framework must be able to sustain changing partner sponsorship and involvement. A partner may drop out or alter its role in the Program, and new members may join. The management structure must be flexible enough to incorporate such changes without compromising safety or user operations.

Assembly and Evolution: The operations framework must provide a smooth transition from the Station's deployment and assembly to "mature operations." While the assembly of the Station elements and deployment of platforms will transpire over a period of years, systems operations will commence with the deployment of the first elements, and user operations will grow as the Station resources to support them are put in place. Hence, the operations framework and organizational structure must support a smooth transition from assembly to mature operations.

The Space Station's success will be measured not only by its ability to meet today's missions, but by its ability to anticipate and accommodate tomorrow's. It is difficult at this point in time to predict which of the prospective users and user communities will drive Station utilization over time. As well, the technology which will be incorporated in the Station elements at deployment will certainly obsolesce as continued advances offer new or more efficient capabilities. The Station must be "organic," and have the flexibility to evolve to meet changing requirements and Program goals.[15]

From the operations perspective, this means having a configuration management and sustaining engineering capability to monitor current performance and conduct analyses of the benefits of prospective upgrades, and a planning system by which decisions to upgrade Station elements or systems can be made by the partners and then incorporated into ongoing operations.

Operations Cost Effectiveness: The long term nature of the Space Station Program enjoins NASA and its partners to more carefully consider operations as a determinant of life cycle costs. Put in its simplest terms, three decades of running the Space Station will cost more than the ten-year development investment.

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[13] *Skylab was the most "Station-like" R&D mission flown to date. Skylab, however, was much more limited in scope and amount of operations: the Space Station will have a much more complex operations integration challenge across its diverse user spectrum. For example, life science researchers may desire special motion-inducing experiments at the same time that microgravity scientists will want to restrict motion on the Station. On the other hand, the Station will not need to have the activity-intensive timelines typical of Shuttle or Spacelab missions, since the Station isn't limited to a 7-10 day stay time. This implies that onboard activity scheduling can be performed with greater "margins" and flexibility in time sequencing.*

[14] *The goals of the international partners as users of Space Station resources are contained in the preceding evaluation criterion.*

[15] *Most of NASA's previous experience base has been with well-defined missions which permit concurrent development of hardware and payloads, each optimized for the other. Since most mission lifetimes have been only a few years, designs could be "frozen" and little consideration given to upgrade once the payload has been launched.*

Thus, the operations framework should recognize cost drivers, and attempt to streamline operations complexity and requirements wherever such actions would produce Program cost savings.

However, the SSOTF strongly believed that cost, while an important consideration, should be a driver only in selecting among options which meet the fundamental workability, safety, user, partner and growth capability criteria. Stated another way, the SSOTF concluded that a less expensive option was not the most cost effective if it entailed unacceptable safety risk, adversely affected the productivity of users, or prohibited partners from realizing their long term Program objectives.

In summary, the relationship of the Evaluation Criteria to the Program goals is depicted in the matrix in Table III-2. The evaluation criteria can have either a direct, indirect, or no correlation to a Program goal. For example, effective Program control indirectly supports most of the discovery and benefit Program goals.[16] There is a more direct correlation between effective Program control and the goals to reduce the costs of space operations.[17] Finally, Program control has an indirect correlation to promotion of international cooperation.[18]

Each option reviewed by the Task Force had to pass each of the criteria before it could be accepted as part of the Recommended Framework. (See the Preface for details of the SSOTF methodology.) Options were evaluated in relative terms: were they unacceptable in meeting the evaluation criteria; were they acceptable; or did they have features which made them especially advantageous? In comparing among options, the prioritized criteria provided the selection process. If two options were considered equal in terms of the most important criteria, the next most important criteria were compared, and so on, until one option "won out."

| PROGRAM GOALS | OPERATIONS EVALUATION CRITERA | PROGRAM CONTROL | PROGRAM SAFETY & SYSTEM INTEGRITY | EFFECTIVE USER OPERATIONS | SUBSTANTIVE INTERNATIONAL PARTICIPATION | ASSEMBLY & EVOLUTION | OPERATIONS COST EFFECTIVENESS |
|---|---|---|---|---|---|---|---|
| ENCOURAGE NEW DISCOVERIES | USER ORIENTED PROGRAM | I | D | D | N/A | I | I |
| | ENHANCE SPACE SCIENCE & APPLICATIONS | I | I | D | N/A | D | I |
| | SUPPORT ADVANCED TECHNOLOGY DEV. (INCLUDING A&R) | I | D | D | N/A | D | I |
| PROMOTE LONG-TERM ECONOMIC BENEFITS | ENHANCE U.S. AEROSPACE PRODUCTIVITY | N/A | N/A | N/A | N/A | I | N/A |
| | SUPPORT COMMERCIAL DEVELOPMENT OF SPACE | I | D | D | N/A | D | I |
| REDUCE COSTS OF SPACE OPERATIONS | PROVIDE FOR COMMONALITY | D | D | I | I | D | D |
| | PROVIDE FOR MAINTAINABILITY | D | D | I | I | I | D |
| | OPTIMIZE HUMAN PRODUCTIVITY | D | I | I | N/A | N/A | D |
| | DESIGN FOR EVOLUTION & GROWTH | I | N/A | I | D | D | D |
| | DESIGN TO LIFE-CYCLE COST | D | N/A | I | I | D | D |
| FOREIGN POLICY | PROMOTES INTERNATIONAL COOPERATION | D | N/A | N/A | D | I | N/A |

D = DIRECT CORRELATION
I = INDIRECT
NA = NOT APPLICABLE

Table III-2 Relating Evaluation Criteria To Space Station Program Goals

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[16] *Effective Program control implies a management structure that will be adept at meeting user requirements and objectives, maximize allocation of resources, etc. It has no correlation to the goal of enhancing U.S. aerospace productivity as defined in Chapter II (enhancing that industry's productivity through participation in hardware development).*

[17] *A strong Program control framework will increase the ability of Program management to coordinate operations, maintain configuration control and commonality among subsystems, make proper tradeoffs in crew vs. ground personnel responsibilities, plan evolution, and take account of life cycle cost considerations.*

[18] *A good control structure enhances any given level of international cooperation by minimizing the chances for misunderstanding and by facilitating smooth operations, but does not bear a direct relationship on whether or not such cooperation should be pursued.*

## III.B. RECOMMENDED FRAMEWORK FOR OPERATIONS

This section presents the Recommended Framework for operations as developed by the SSOTF. First, a short synopsis of the management and planning hierarchy is presented. The Recommended Frameworks for the manned base and unmanned platforms are then presented separately.

### III.B.1. Introduction

The central feature of the Recommended Framework is the provision of hierarchical utilization and operations planning and control: the process by which system and user requirements are identified, integrated into an operating plan, and implemented. Other functions are carried out largely to support this function. Hence, a description of the Framework centers largely on the end-to-end flow by which strategic objectives for Space Station utilization and operations are formulated and carried out at each management level.

The SSOTF further detailed the operations functions presented in Figure III-1, and then hierarchically grouped the resultant subfunctions into three basic levels of management and control: Program Policy ("strategic"), Program Integration ("tactical") and Program Execution (real-time operations).[19] This management hierarchy exercises control over four levels of planning, each of which has one or more major planning products associated with it. The four planning levels are: Strategic Utilization and Operations Planning (five-year planning horizon); Tactical Utilization and Operations Planning (two-year planning horizon); Increment Planning (development of detailed planning and scheduling data for an increment specific timeframe); and Increment Execution Planning (development of execute level plans and procedures to perform increment operations in real- time). The Program Integration (tactical) level of management controls both the Tactical Utilization and Operations Planning and Increment Planning functions. This hierarchy, and the major planning products associated with each management level are presented in Figure III-2.[20]

### Program Policy

Program Policy functions establish and coordinate the strategic objectives of the Program for users and system operators. The Strategic Utilization and Operations Planning function develops the long term plan for Station operations. The major product developed at this level is the Consolidated Utilization Plan (CUP). The CUP is the basic reference document for Station operations and utilization, and covers a five-year planning horizon. It is a "document of intent" which lists all of the payloads which the Program (NASA and its partners) would like to fly.[21] The CUP normally will be updated on an annual basis.[22]

The CUP is approved by the Multilateral Control Board (MCB). The MCB will comprise senior representatives of all Program partners, and will be chaired by the NASA Associate Administrator responsible for Space Station operations. Station system requirements will be developed by an international Systems Operations Panel (SOP). User requirements will be collated by an international User Operations Panel (UOP) and integrated with system requirements to form the CUP.[23]

### Program Integration

Program Integration functions implement objectives and policies produced at the Program Policy level through the development and management of more detailed plans and directives. The content of the functions becomes progressively more "technical" as the function moves from a "pure policy" content towards end products for Program Execution. Program integration functions are accomplished in two steps: the development of overview increment manifests through a two-year tactical utilization and operations

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[19] *Many times, a single function (such as utilization and operations planning), will extend through all levels of management, while other functions (such as systems operations and user operations support) are generally associated with a single management level (Program Execution in this case). Hence, many functions will be performed simultaneously at multiple levels of management, and in multiple organizations within a single level of management. A complete regrouping of operations functions by level of management responsibility is presented in Appendix B of this report.*

[20] *The control and product flow which follows is presented in a "top-down" fashion. Each level of activity develops a "product" which is used at the next lower level as guidance for its activity. This process continues until the "end product" (i.e., execution of operations) occurs. While it is not discussed in detail here, the hierarchy also has a reciprocal feedback path. Completion of execution operations is documented and passed upwards as a "product," which is used as input at the next higher level for development of an operations review product, and so on. In this way planners at the top of the hierarchy provide direction to "doers" at the bottom, who in turn produce the information which allows those at the top to gauge the efficiency of the Program in meeting goals.*

[21] *Program Integration level manifest assignments can only be made following more detailed analyses of payload interfaces with the various operational aspects of the Program, as well as with other payloads selected to fly in the same time period.*

[22] *The Task Force believed that an annual review would be sufficient, but many noted that extraordinary circumstances (either in response to unexpected Program contingencies or opportunities) might dictate ad hoc or more frequent strategic utilization and operations planning requirements. Conversely, it was also recognized that the process may not be necessary on an annual basis if utilization and operations requirements are "stable."*

[23] *Inputs to the UOP are provided by the partner Space Station User Boards (SSUBs) which are managed by the user communities of each partner. The SSUBs provide utilization resource projections and requirements by user group to the UOP for integration with the systems requirements in the CUP for final approval by the MCB. (See Section III.B.2 and the User Development and Integration Panel report for a further description of the SSUB function.) The UOP will be chaired by the Program Integration level NASA Program Scientist.*

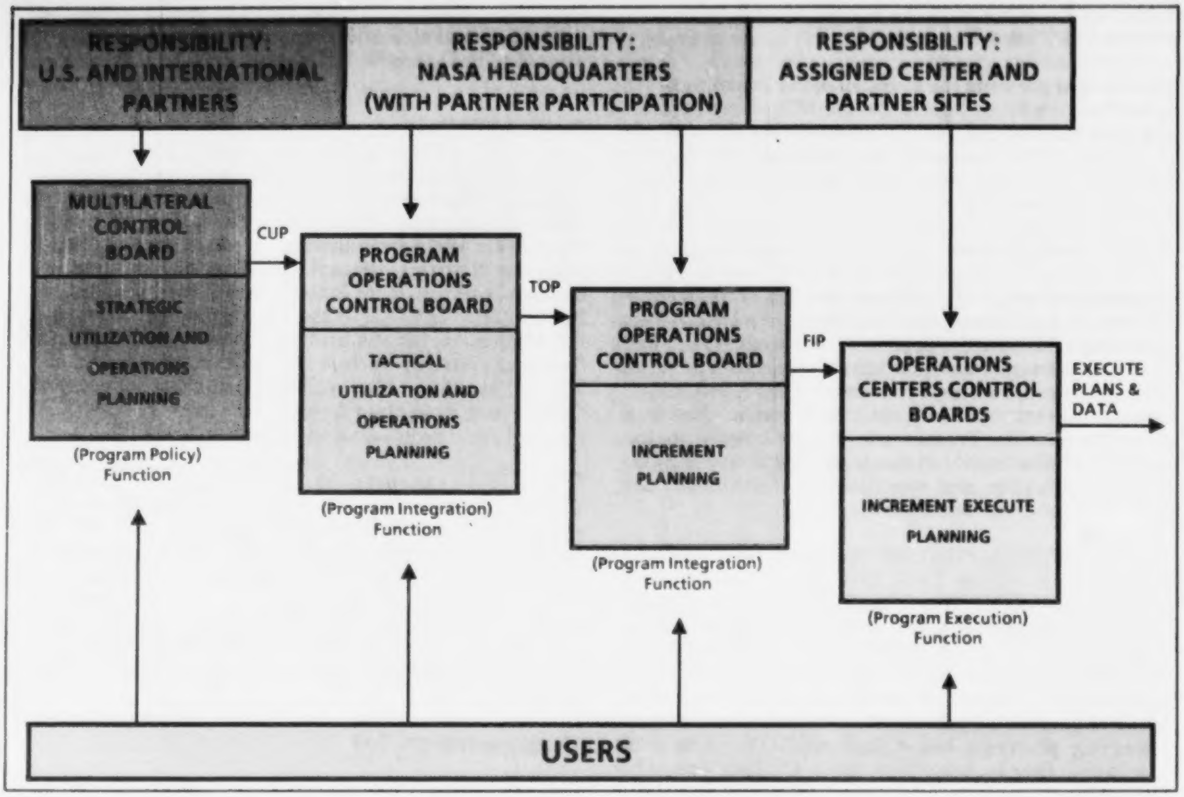
RESPONSIBILITY: U.S. AND INTERNATIONAL PARTNERS
RESPONSIBILITY: NASA HEADQUARTERS (WITH PARTNER PARTICIPATION)
RESPONSIBILITY: ASSIGNED CENTER AND PARTNER SITES
MULTILATERAL CONTROL BOARD
STRATEGIC UTILIZATION AND OPERATIONS PLANNING
(Program Policy) Function
CUP
PROGRAM OPERATIONS CONTROL BOARD
TACTICAL UTILIZATION AND OPERATIONS PLANNING
(Program Integration) Function
TOP
PROGRAM OPERATIONS CONTROL BOARD
INCREMENT PLANNING
(Program Integration) Function
FIP
OPERATIONS CENTERS CONTROL BOARDS
INCREMENT EXECUTE PLANNING
(Program Execution) Function
EXECUTE PLANS & DATA
USERS

**Figure III-2 Recommended Framework Planning And Control Hierarchy**

planning process, and the development of detailed increment objectives through a flight increment planning process. Program Integration level functions require personnel who can bridge both worlds: who have a "global view" of the Program's objectives and a technical understanding of the capabilities and limitations of the Program elements and control structure.[24]

The key product of the tactical utilization and operations planning process is the Tactical Operations Plan (TOP). The TOP assigns system maintenance and operations activities and user payloads contained in the CUP to specific flight increments.[25] The TOP will be approved by the internationally staffed Program Operations Control Board (or POCB, again chaired by NASA), and developed by "utilization" and "system" control panels (UCP and SCP). User input will come from the CUP, with more detailed requirements provided to the Utilization Control Panel by the Space Station Users Working Group (SSUWG).

The Flight Increment Plan (FIP) contains the information required by the operations execution team to perform execution level planning for a specified flight increment. FIPs will be developed by an Increment Change Management Team. Each increment will have an Increment Change Manager who coordinates the required planning and analysis activities. Investigators Working Groups (IWGs), comprised of the users selected for each increment (or their discipline representatives), will work closely with the Increment Change Managers in developing schedules. The POCB will have responsibility for ensuring that sequential FIPs are compatible, and all Increment Change Managers will report through the POCB.

Program Safety Review Boards reside at the Program Integration level, and exercise oversight at all levels of management and operations. These review boards will be staffed by the Program, but chairmen will be supplied by the independent Headquarters SRM&QA organization.

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[24] *Program Integration planning activities are subdivided into "tactical operations" (integrated planning activities with a 2-year planning horizon) and "increment operations" (activities associated with planning a specific flight increment).*

[25] *Since the SSOTF assumed an average of eight STS flights per year (an average of one every 45 days), the TOP would include 16 flight increments. The TOP will include overview data generated in the Flight Increment Plans; however, the FIPs are much more detailed documents and are "stand-alone" products.*

The Task Force recommends that Program Policy and Program Integration functions should be the responsibility of the Space Station organization at NASA Headquarters. This would provide a focal point for Agency roles and mission policy, a single interface for international negotiations, and a means of coordinating multiple operations and engineering support centers. It also provides a high level interface to NASA's other program organizations.

**Program Execution**

Program Execution level functions result in institutional end products (e.g., detailed onboard timelines and procedures for a period of operations), and the actual implementation of the details of a plan in support of a specific end product (e.g., ground personnel performance of a system test and verification check). These functions will be distributed to the relevant operations centers or "centers of expertise." A summary flow of the program control documentation is presented in Figure III-3.

Increment Execution Planning entails detailed planning and production of operations and utilization execution plans, and real-time replanning of operations in response to contingencies or new opportunities. Execute level products include the plans, procedures and constraints required by the operations support centers' ground personnel as well as the onboard crew for performance of daily duties and assigned tasks.[26] Execution functions include ground prelaunch and postlanding equipment processing, crew training and in-flight operations, monitoring and control of Station elements and their payloads, sustaining engineering analyses which support real-time operations, and the operation of the ground support network.

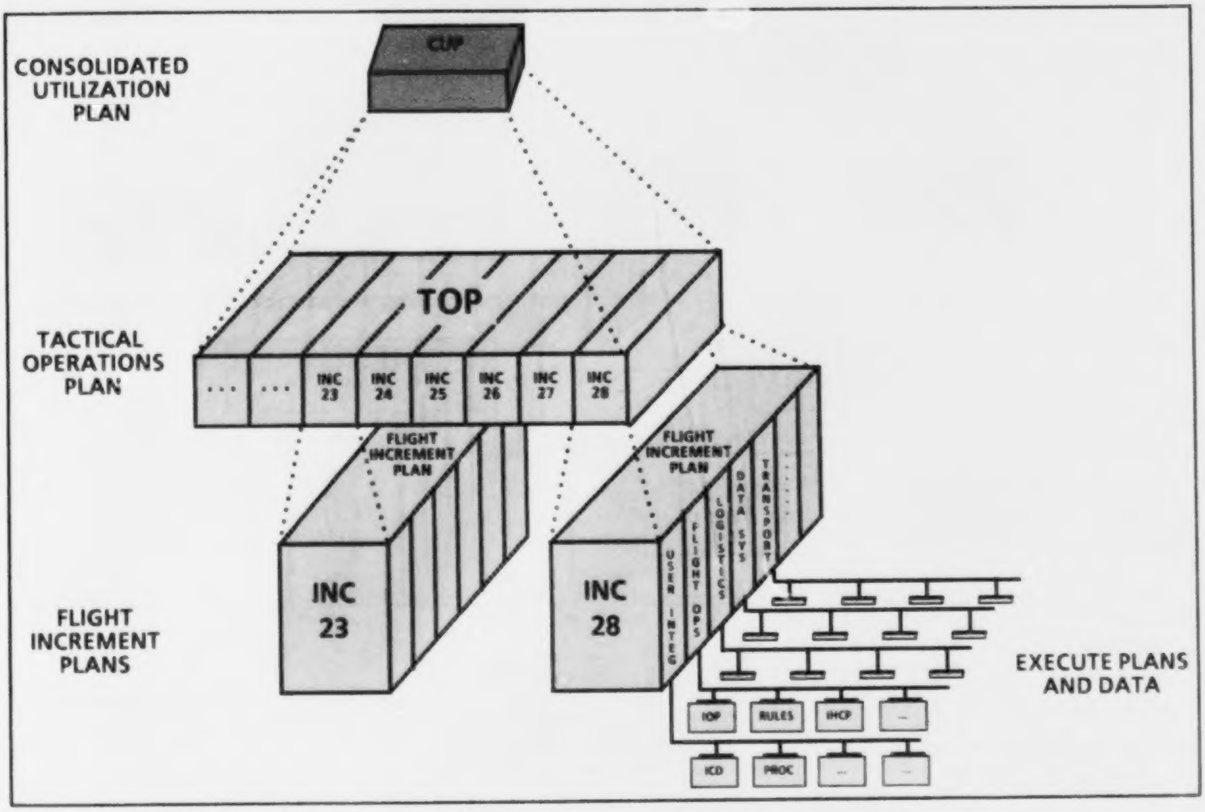

**Figure III-3 SSOTF Operations Framework Program Control Documentation Hierarchy**

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[26] *Execution plans and data developed at this planning level include the Increment Operations Plan (IOP), Flight Data File (FDF), Increment Hazard Control Plan (IHCP), Flight Rules, Reconfiguration Data and other real-time execution plans and supporting documentation derived from the FIP.*

Responsibility for execution operations will be vested at the assigned NASA centers and international partner sites. The SSOTF assumed that these various NASA field center and international partner implementing organizations would define the necessary preflight and real-time control mechanisms required to implement their assigned Station responsibilities. Figure III-4 provides a summary of the control mechanisms proposed for all the management levels of the Recommended Framework, and their interactions with the Program planning process.

### III.B.2. Manned Base Operations Framework

The Task Force recommends managing multiple elements of the manned base as an integrated facility rather than as a collection of autonomous elements.[27] This funda-mental characteristic is driven by the Program's complexity in both systems and user operations. The extra layers of management coordination needed to maintain the facilities and operations under separate organizations would impede efficient manned base operations. Operations safety on the manned base would also be more difficult to achieve if operations across elements were not coordinated in planning and execution. From the user perspective, separately managed elements would greatly complicate pre-flight and flight activities. User interfaces would be much more complex; the number of steps for selecting, manifesting and integrating users would multiply, adding unnecessary requirements on them. Onboard activities would also lose flexibility, as real-time replanning of user operations would become much more cumbersome.[28]

The Task Force also recommends that NASA assume the lead role in manned base management and operations. The Task Force believes that this is a logical approach, based on NASA's significantly larger contribution to the Program and its more extensive manned systems operations experience. In the Recommended Framework, planning and control of operations will be focused in the NASA Space Station operations organization; NASA will chair the management control boards governing Station operations at the strategic and tactical levels. NASA will also retain

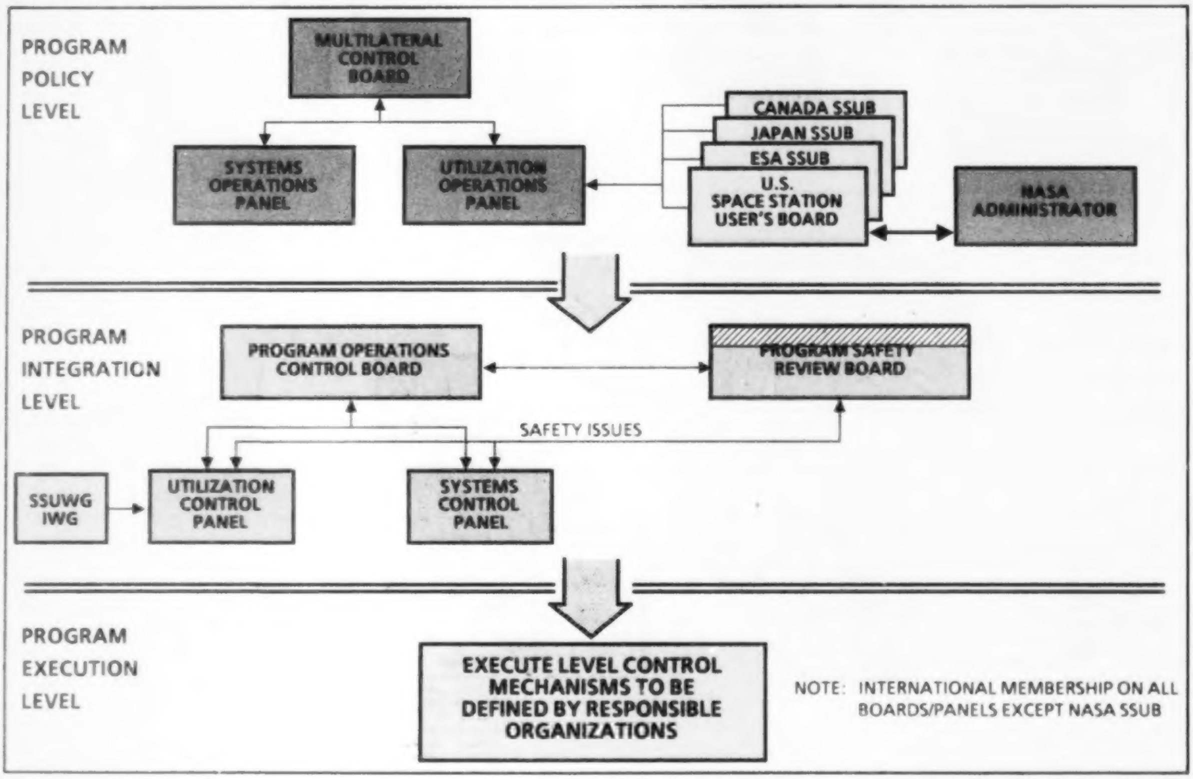
PROGRAM
POLICY
LEVEL
MULTILATERAL CONTROL BOARD
SYSTEMS OPERATIONS PANEL
UTILIZATION OPERATIONS PANEL
CANADA SSUB
JAPAN SSUB
ESA SSUB
U.S. SPACE STATION USER'S BOARD
NASA ADMINISTRATOR
PROGRAM
INTEGRATION
LEVEL
PROGRAM OPERATIONS CONTROL BOARD
PROGRAM SAFETY REVIEW BOARD
SAFETY ISSUES
SSUWG IWG
UTILIZATION CONTROL PANEL
SYSTEMS CONTROL PANEL
PROGRAM
EXECUTION
LEVEL
EXECUTE LEVEL CONTROL MECHANISMS TO BE DEFINED BY RESPONSIBLE ORGANIZATIONS
NOTE: INTERNATIONAL MEMBERSHIP ON ALL BOARDS/PANELS EXCEPT NASA SSUB

Figure III-4 Program Control Summary

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[27] *This is in contrast to operations of multiple platforms which are planned and performed with a high degree of individual "element" autonomy.*

[28] *The dictates of limited common resources, and the unavoidable propagation of physical conditions from one element to another, require manned base schedules and manifests to be carefully balanced; the development of several "mini-manifests" would make it difficult to respond to a user replanning request in one element which might affect several separate timelines. A centralized operations management structure with a "system-wide" view would be in a better position to make tradeoffs and conduct replanning activities.*

overall responsibility for manned base and crew safety. International partners will participate in all levels of the operations planning and management structure on an integrated basis.

The Task Force assumes that users will opt to conduct their planning activities in a "distributed" manner (at geographically dispersed sites or in demographically diverse groups). User planning activities are brought together at the Program Policy level by the international Multilateral Control Board. At the Program Integration level, user activities are conducted by user working groups and supported by Station accommodation offices, while at the Program Execution level user activities are coordinated by a payload operations integration function.

A typical day's activity for the manned base will be analogous to the operation of a multifunctional research and development complex on Earth. The range of Station operations activities for the manned base are depicted in Figure III-5. These include: operations and utilization planning (determining who uses the Station for what purposes); logistics operations support (activities associated with preparing men and material for transport to and from the manned base); space operations (activities which transpire onboard the Station); and space operations support (ground-based activities which help maintain the integrity of the manned base assets in orbit).

### III.B.2.a. Strategic Utilization and Operations Planning

The basic purpose of Strategic Utilization and Operations Planning is to allocate Station resources to systems and user requirements.[29] Figure III-6 depicts the planning process for development of the Consolidated Utilization Plan. This activity will transpire at NASA Headquarters.

The MCB will have approval authority for this function, with the primary product at this level being the Consolidated Utilization Plan (CUP). The strategic planning function will have three primary sources of

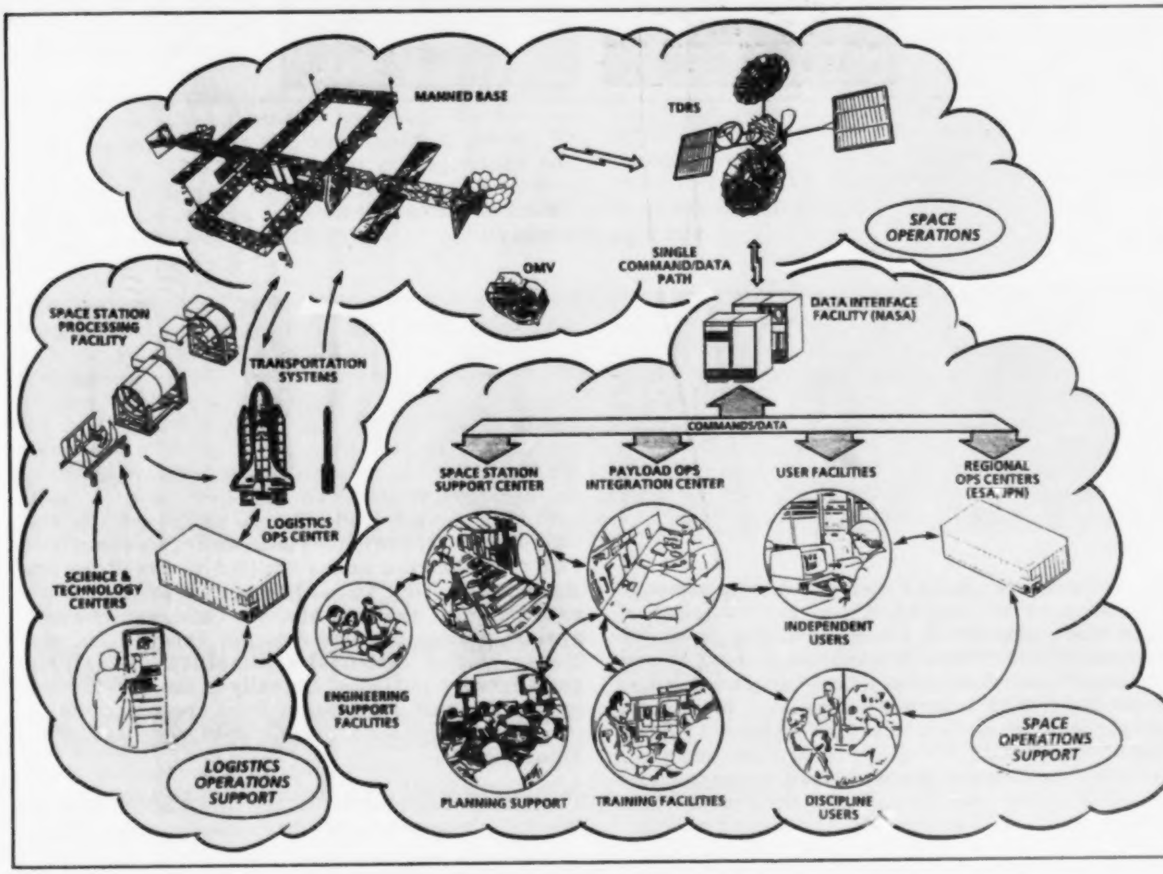
MANNED BASE
TDRS
SPACE OPERATIONS
SINGLE COMMAND/DATA PATH
OMV
DATA INTERFACE FACILITY (NASA)
SPACE STATION PROCESSING FACILITY
TRANSPORTATION SYSTEMS
COMMANDS/DATA
SPACE STATION SUPPORT CENTER
PAYLOAD OPS INTEGRATION CENTER
USER FACILITIES
REGIONAL OPS CENTERS (ESA, JPN)
LOGISTICS OPS CENTER
SCIENCE & TECHNOLOGY CENTERS
INDEPENDENT USERS
ENGINEERING SUPPORT FACILITIES
SPACE OPERATIONS SUPPORT
LOGISTICS OPERATIONS SUPPORT
PLANNING SUPPORT
TRAINING FACILITIES
DISCIPLINE USERS

Figure III-5 Manned Base Operations Infrastructure

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[29] *Systems allocations include resources required to maintain the existing elements on orbit, and to incorporate upgrades, block changes or additions to them. Utilization allocations include assignments on the basis of partner and user groups, and the selection and prioritization of individual payloads.*

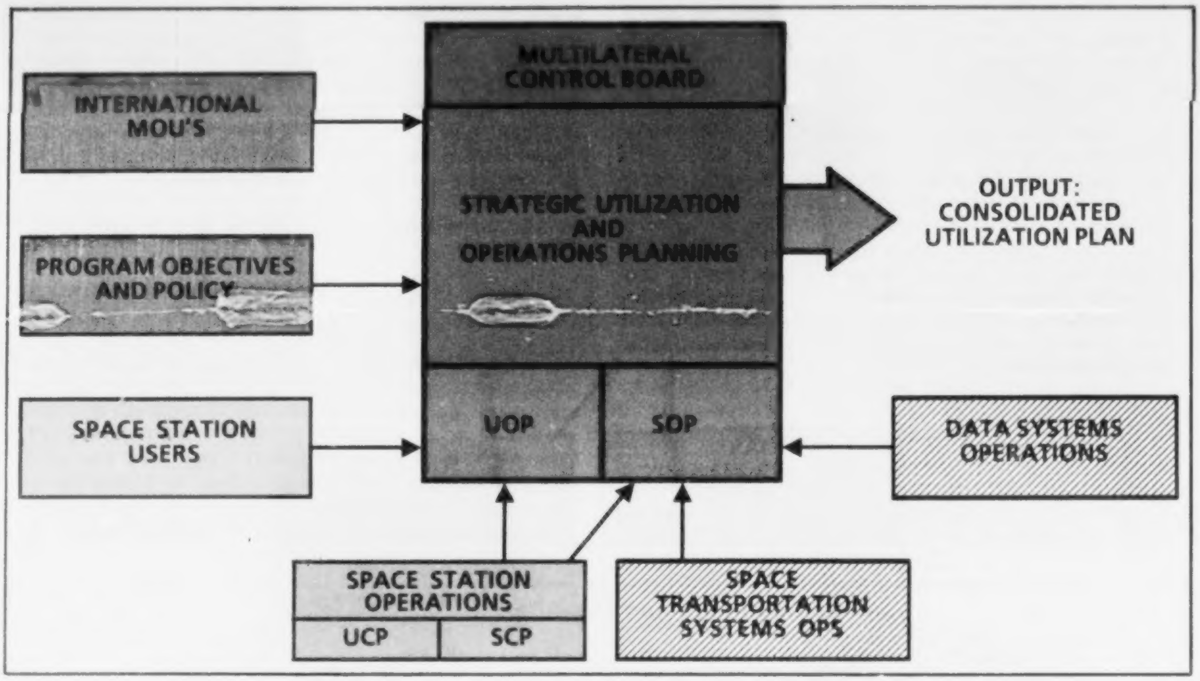
MULTILATERAL CONTROL BOARD
INTERNATIONAL MOU'S
PROGRAM OBJECTIVES AND POLICY
SPACE STATION USERS
STRATEGIC UTILIZATION AND OPERATIONS PLANNING
UOP
SOP
OUTPUT: CONSOLIDATED UTILIZATION PLAN
DATA SYSTEMS OPERATIONS
SPACE STATION OPERATIONS
UCP
SCP
SPACE TRANSPORTATION SYSTEMS OPS

**Figure III-6 Manned Base Operations Framework Strategic Planning**

input: broad policy and objectives provided through international memoranda of understanding (MOUs) and in-place policy statements (with periodic updates as required); systems operations requirements collected by the SOP (including transportation needs, data systems requirements and actual manned base systems performance data); and projected payload requirements collected by the UOP from the user community (including actual payload performance data).

The Systems Operations Panel will develop strategic requirements for operation and maintenance of manned base elements.[30] The SOP will also provide for analysis of Space Station evolution objectives and planning, based on analyses of user requirements (i.e., demands for more or new resources) and input from partner and outside technology development efforts. The SOP will work closely with the transportation systems and space data systems operations organizations for projections of transportation and data systems availability as inputs to the planning process.

International MOUs, and other Program policy documents will provide the basic guidance for allocation of utilization resources. While resources will be assigned to Station elements, "ownership" of those resources will be held by the Program partners as determined by MOU, to be assigned by partner SSUBs.[31] Each partner's SSUB establishes schedule and discipline priorities for its respective users along with specific requirements to be accommodated by the manned base (or one of the platforms). These priorities and requirements are submitted to the Program through the UOP. The UOP and SOP jointly coordinate Program analyses of these user requirements against Station systems resource capabilities and transportation system(s) availability. Resulting guidelines are published annually in the CUP for use by the Program Integration level organizations in manifesting payloads to specific flight increments. (See Figure III-7.)

The SSOTF recommends that the NASA SSUB allocate "blocks" of resources to the major user sponsors. These

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[30] *As the MCB's "agent" for strategic systems planning, the SOP is concerned with planning for those space systems maintenance requirements or technology upgrades to the manned base and platforms which will have a significant impact (brief or long term) to overall Program resource availability and/or utilization. Routine maintenance activities are planned and scheduled at the Program Integration and Program Execution levels of the Program.*

[31] *The allocation formula will most likely be based on some relation of development and operations costs supported by each partner. Since it is assumed that NASA will bear the majority of development and operations costs, a significant portion of resources allocated to the JEM and Columbus modules will be reserved for U.S. users.*

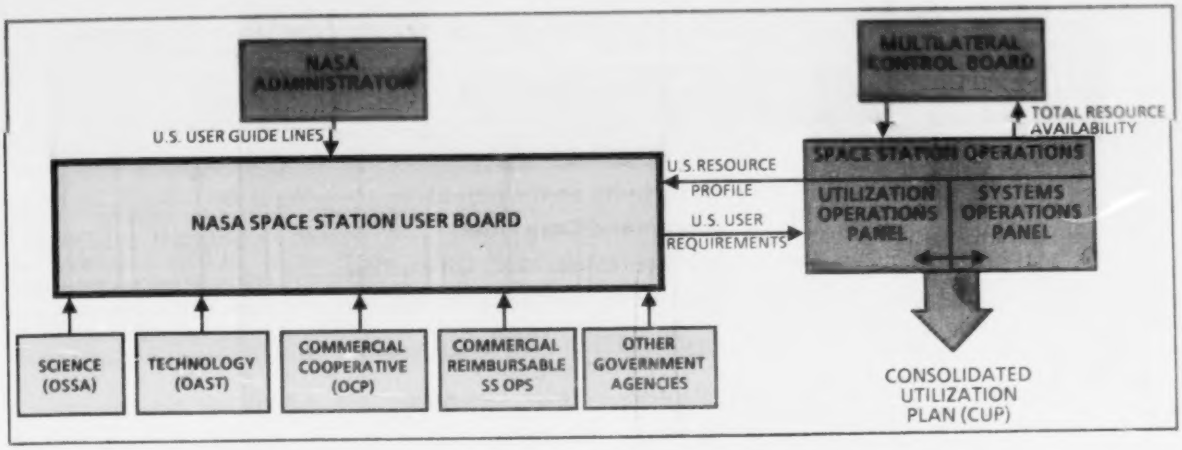
NASA ADMINISTRATOR
U.S. USER GUIDE LINES
NASA SPACE STATION USER BOARD
SCIENCE (OSSA)
TECHNOLOGY (OAST)
COMMERCIAL COOPERATIVE (OCP)
COMMERCIAL REIMBURSABLE SS OPS
OTHER GOVERNMENT AGENCIES
MULTILATERAL CONTROL BOARD
TOTAL RESOURCE AVAILABILITY
U.S. RESOURCE PROFILE
U.S. USER REQUIREMENTS
SPACE STATION OPERATIONS
UTILIZATION OPERATIONS PANEL
SYSTEMS OPERATIONS PANEL
CONSOLIDATED UTILIZATION PLAN (CUP)

Figure III-7 User Role--Strategic Planning

groups include the NASA user codes and other government agencies.[32] The sponsors would be represented on the SSUB by a NASA Associate Administrator, or his equivalent for the non-NASA users. Partners can structure their SSUBs to meet their specific requirements.

Each sponsor would then select candidate payloads through an internal review process. The Station Program will support the user selection process by conducting feasibility studies to determine the Program's ability to support the various candidate payloads, and through provision of general marketing support to inform users of the Station's capabilities.

Sponsors would submit their candidates to the User Boards for approval, prioritization, and recommendation for flight scheduling. Each SSUB would then submit its annual "block" of prioritized users to the UOP, which would develop a draft integrated user plan. This plan would then be integrated with system requirements provided by the SOP to result in the development of a draft CUP. The Consolidated Utilization Plan will be published annually following MCB approval (or more frequently as required). Resources which would be allocated in the CUP are listed in Table III-3. A typical CUP overview for the year 1995 is presented in Table III-4.

***KEY FEATURES OF THE STRATEGIC UTILIZATION AND OPERATIONS PLANNING PROCESS***

- *The international MOUs establish the basic partner resource allocation policies.*
- *The planning process allows decentralized generation of utilization priorities through SSUBs, which are then collected and implemented through a centralized Program planning process.*
- *Users will perform utilization planning, resource allocation and selection within broad resource guidelines and under the direction of the partner User Boards.*
- *The Station Program will provide continuing safety, engineering, and operations support to users.*
- *The major planning product is the Consolidated Utilization Plan (CUP) which establishes the manned base, platforms, and user resource allocation guidelines over a five-year period. (See Table III-4).*

### III.B.2.b. Tactical Utilization and Operations Planning

The goal of the integrated tactical planning process is the development of a two-year manifest for manned base utilization and operations. The Program Operations Control Board (POCB), located at NASA Headquarters, will have approval responsibility for this function. Like the MCB, the POCB will be chaired by NASA, and staffed by NASA and its partners. The sources of user input for the POCB include the Consolidated Utilization Plan, and detailed payload data from the Space Station Users Working Group (as coordinated by the SSUWG Steering Committee), and

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[32] *The Office of Space Science and Applications would sponsor traditional Code E science activities; the Office of Aeronautics and Space Technology (Code R) would sponsor technology development users. Academic users would be sponsored by the NASA office most appropriate to their particular activity. The Office of Commercial Programs (Code I) would sponsor all commercial activities which involved cooperative agreements between NASA and industry. The Office of Space Station would sponsor reimbursable commercial payloads. Other U.S. government usage (e.g., DOD and NOAA) and reimbursable non-partner foreign payloads would represent themselves. User outreach and marketing support is shared by the user sponsors and the Station Program. The Program will be responsible for providing general marketing information on Station systems and capabilities to support the user sponsors, and will also have the direct responsibility for marketing commercial reimbursable users (or other reimbursable users which approach the Program for information).*

## ON-ORBIT RESOURCES TO BE ALLOCATED AND MANAGED

Crew Time (IVA, EVA)
Power
Payload Rack Space
Microgravity Environment
Command/Data Flow
General Storage (trash, food, ORUs, etc.)
ECLSS Capabilities and Consumables
Thermal Control
Clear Pointing Arcs
Station Reboost Consumables
Flight Telerobotics System
External Servicing Facility
OMV
Up and Down Mass
External Payload Attach Points

Table III-3 Resources Allocated In The Consolidated Utilization Plan

| CUP OPERATIONS DATA | | |
|---|---|---|
| APPLICABILITY | RESOURCE AVAILABILITY (SOP) | RESOURCE UTILIZATION (UOP) |
| 5TH OUTYEAR (2000) | • PARTNER ACCOUNTABILITIES & RESPONSIBILITIES<br>• LAUNCH VEHICLE SYSTEMS CAPABILITIES<br>• SPACE SYSTEMS RESOURCE OVERHEAD SUMMARY<br>• OMV/FTS SYSTEM CAPABILITIES<br>• GROUND SYSTEMS UTILIZATION PLAN<br>• DATA SYSTEMS PLAN<br>• CREW SKILL MIX PROJECTIONS | • MARKET REPORT - USER INQUIRIES & ADVOCACY GROUP STUDIES<br>• PARTNER UTILIZATION SHARES (MCB-DERIVED)<br>• USER CLASS SHARES (SSUB-DERIVED) |
| 4TH OUTYEAR (1999) | • UPDATE PREVIOUS DATA | • UPDATE PREVIOUS DATA & ADD:<br>– I.D. NEW MCB-APPROVED P/L'S; INCLUDE:<br>- SPONSOR<br>- CONTRACT RQMTS<br>- OPS & SERVICING SCENARIO<br>- OPS ASSESSMENT STRATEGY |
| 3RD OUTYEAR (1998) | • UPDATE PREVIOUS DATA | • UPDATE PREVIOUS DATA & ADD:<br>– "QUICK IS BEAUTIFUL" RESOURCE RESERVES<br>– FOR EACH APPROVED P/L:<br>- USER OPS INCREMENT PREFERENCE<br>- CREW SKILL MIX/PS RQMTS<br>- SSIS I/F STRATEGY<br>- PIP/LSA/MRDB STATUS<br>- PDR/CDR SCHEDULES<br>- H/W INTEGRATION STRATEGY<br>- I.D. OPS ISSUES & RESOLUTION STRATEGY |
| 2ND OU[illegible]EAR (19[illegible]) | • UPDATE PREVIOUS DATA & ADD:<br>- INCREMENT PERFORMANCE RESERVE RQMTS<br>- SYSTEMS PERFORMANCE ISSUES & RESOLUTION STRATEGY | • UPDATE PREVIOUS DATA & ADD:<br>– FOR EACH APPROVED P/L:<br>- PROGRAM REVIEW MILESTONE SCHEDULE<br>- ESTABLISH INCREMENTS |
| NEXT YEAR (1996) | • UPDATE PREVIOUS DATA & ADD:<br>- SYSTEMS FLIGHT READINESS STATUS BY INCREMENTS | • UPDATE PREVIOUS DATA & ADD:<br>– FOR EACH APPROVED P/L:<br>- P/L PRIORITY WITHIN ITS DISCIPLINE/INCREMENT<br>- PROGRAM REVIEW MILESTONE STATUS<br>- FLIGHT READINESS SUMMARY |

ASSUMPTIONS:
1 5-YEAR PROJECTION OF INTERNATIONAL SPACE SYSTEM & USER SYSTEM MANNED BASE AND PLATFORMS OPS
2 SEPARATE MANNED BASE AND PLATFORM SECTIONS
3 UPDATED ANNUALLY BY SOP AND UOP AT END OF PREVIOUS OUTYEAR; APPROVED BY MCB

Table III-4 Consolidated Utilization Plan Contents Overview

requirements databases. Systems inputs will be drawn from the operations and development centers, and the launch operations organizations.

The primary product at this level is the two-year Tactical Operations Plan (TOP). The TOP is essentially a compilation of key planning data regarding transfer operations,[33] payload operations, element systems operations, onboard crew operations and related training, logistics operations, and transportation systems requirements. This data is scheduled on an increment-by-increment basis for a two-year period. The process for developing a Tactical Operations Plan is presented in Figure III-8 and an overview of the contents of a TOP is presented in Table III-5.

When considering the step-by-step process of developing a TOP, it is important to recognize that it is a constantly changing document. The TOP is published on an increment-by-increment basis. Hence, it is updated with the initiation of each flight increment on orbit, and the "entrance" of a new increment at the end of the TOP coverage period. As well, individual increments within the TOP evolve as they move through the queue. Additions are made as user and system payload requirements are refined, or in response to new empirical data on systems and payload requirements, in-flight changes or failures of either Station systems or user payloads, transportation capabilities, and other increment planning inputs.

The POCB's Systems Control Panel (SCP) fulfills an analogous role to the MCB's Systems Operations Panel. The SCP is responsible for determining system resource requirements across the two-year TOP horizon. The SCP will draw on the resources of the manned base increment planning and operations execution organizations: the Space Station Support Center for space operations, sustaining engineering, and crew training and operations; the Logistics Operations Center for logistics operations support, and pre and post- flight operations support from the launch site processing organization (including actual outputs from the Space Station Processing Facility). The SCP must also work directly with the transportation systems operations organization(s) and the data systems operations organization(s) for their respective support analyses.[34]

The Utilization Control Panel (UCP) operates analogously to the User Operations Panel at the strategic level: it is the coordinating body which integrates user community requirements for Program Integration level planning. Primary user inputs to the UCP include the Consolidated Utilization Plan, the Space Station Users Working Group and Investigators Working Groups (IWGs) for each increment, the Mission Requirements Database, the Payload Accommodation Managers, and actual payload operations data from the POIC. Modifications to individual increments will be developed and proposed by Increment Change Management Teams. (See below.)

The UCP's draft manifests will be sent to the SCP for integration with manned base system, transportation system and data system requirements. The draft TOP is reviewed by the responsible operations organizations before it is finalized and approved by the POCB. New increment manifests contained in the TOP serve as the departure point for more detailed Increment Planning and Increment Execute Planning activities. The Strategic and Tactical Utilization and Operations Planning flow is summarized in Figure III-9.

### III.B.2.c. Increment Planning

Increment planning is the next step in the planning process: the development of increment-specific data which in turn is used to produce detailed resource utilization schedules, activity templates, procedures and operations support data in advance of the final processing, launch and integration of payloads and transfer of crew. This function is coordinated at NASA Headquarters, with support as required from the responsible field center operations organizations (including partner organizations).

Increment manifests approved in the TOP must be amplified so as to provide specific directives for operations execution planning organizations. Payloads selected in the CUP and manifested in the TOP must be defined in terms of resource requirements for a specific increment (e.g., mass, volume, and logistics support parameters). Resource parameters for payloads which will be integrated into the manned base prior to the commencement of the increment must be updated and modified as projections or actual experience warrant. Likewise, updated Station overhead requirements, consumables projections, maintenance, and common systems capabilities must be detailed for the specific increment. Table III-6 illustrates the range of typical contents of the FIP.

The process for developing a Flight Increment Plan is depicted in Figure III-10. Each increment is assigned a dedicated Increment Management Team (IMT), headed by an Increment Change Manager. The team consists of the personnel listed in Figure III-10 under Space Operations, Integrated Logistics Operations, Data Systems Operations and Transportation Systems Operations.[35]

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[33] *Transfer operations include those activities associated with the transfer and set-up of payloads from the STS or ELVs into the manned base. Transfer operations begin prior to STS arrival (systems housekeeping and preparation of equipment for return to Earth) and extend through STS departure and subsequent installation (and checkout, if immediately required) of the newly delivered equipment.*

[34] *Interaction with the transportation operations organization is required to develop STS or ELV manifests, and to coordinate payload-to-transportation system interface analyses. Coordination with the data systems organization will enable the Program to account for changes in data support capability (e.g., a change due to initiation, modification or termination of a non-Space Station program).*

[35] *At first, the team consists only of "core" members associated with planning the details of the increment at that time (including representatives from the transportation and data systems organizations). As the increment draws nearer, the team is expanded to include the support personnel who will actually execute the Increment Plans. The evolution of the Increment Management Teams is analogous to the way in which the Mission Control Center (MCC) flight control teams evolve as an STS flight draws nearer.*

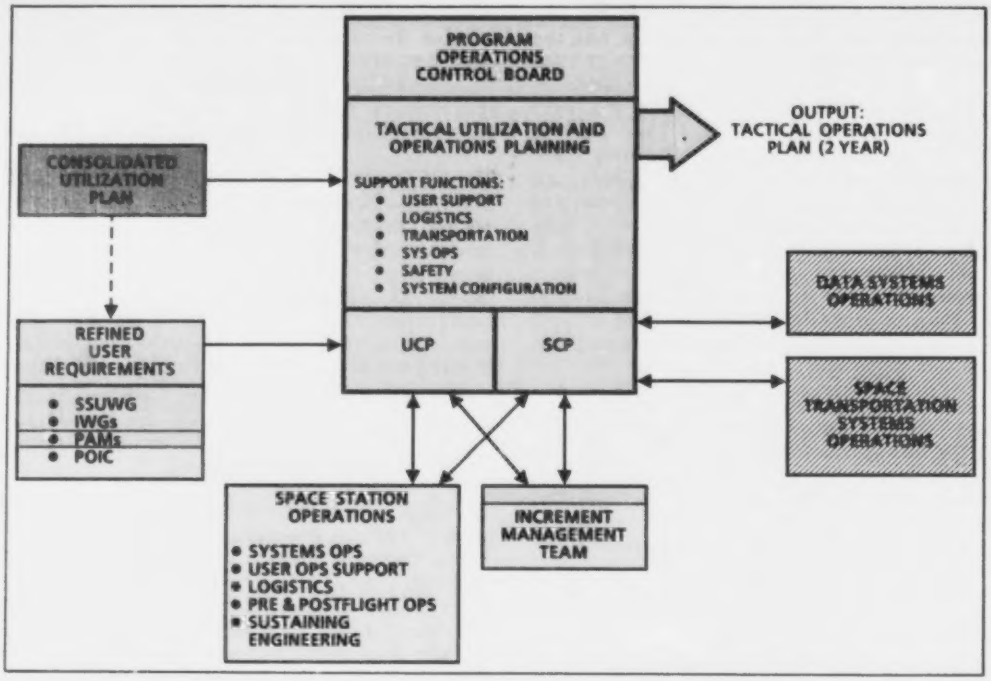

PROGRAM OPERATIONS CONTROL BOARD
TACTICAL UTILIZATION AND OPERATIONS PLANNING
SUPPORT FUNCTIONS:
• USER SUPPORT
• LOGISTICS
• TRANSPORTATION
• SYS OPS
• SAFETY
• SYSTEM CONFIGURATION
OUTPUT: TACTICAL OPERATIONS PLAN (2 YEAR)
CONSOLIDATED UTILIZATION PLAN
REFINED USER REQUIREMENTS
• SSUWG
• IWGs
• PAMs
• POIC
UCP
SCP
DATA SYSTEMS OPERATIONS
SPACE TRANSPORTATION SYSTEMS OPERATIONS
SPACE STATION OPERATIONS
• SYSTEMS OPS
• USER OPS SUPPORT
• LOGISTICS
• PRE & POSTFLIGHT OPS
• SUSTAINING ENGINEERING
INCREMENT MANAGEMENT TEAM

Figure III-8 Manned Base Operations Framework
Integrated Tactical Planning

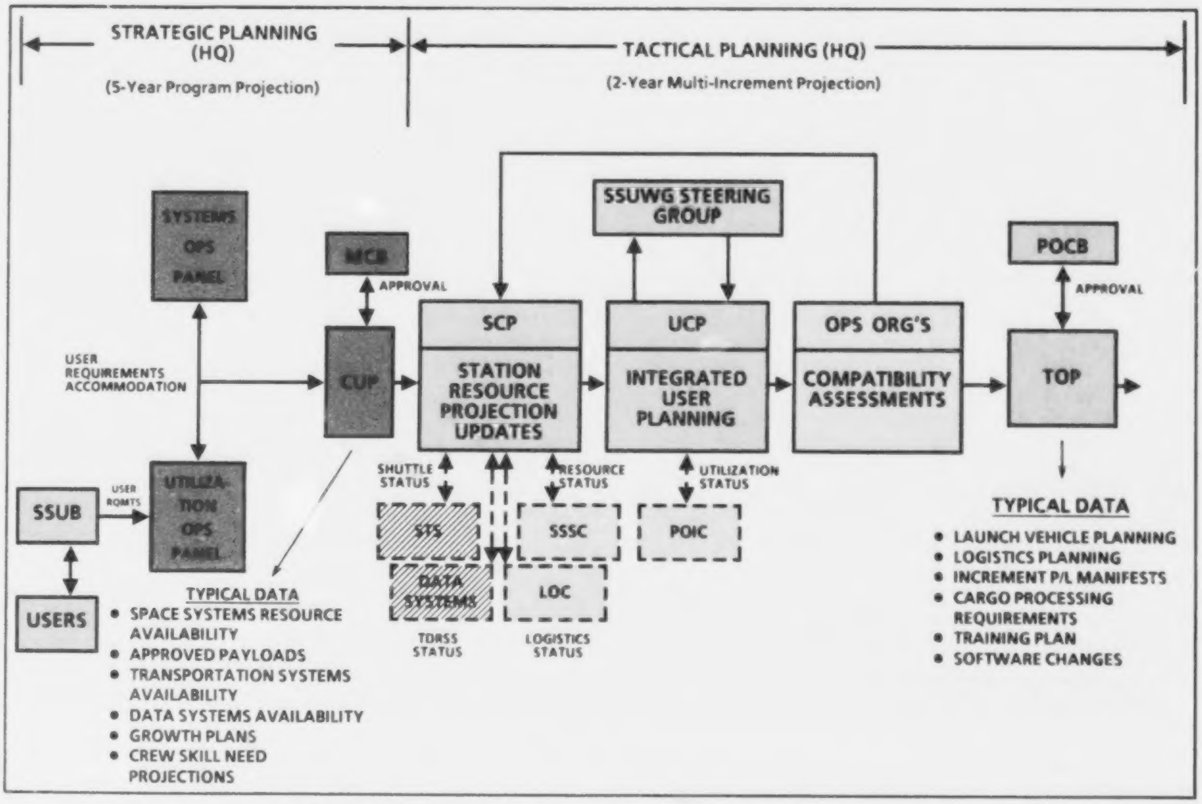

STRATEGIC PLANNING (HQ)
(5-Year Program Projection)
TACTICAL PLANNING (HQ)
(2-Year Multi-Increment Projection)
SYSTEMS OPS PANEL
MCB
APPROVAL
SSUWG STEERING GROUP
POCB
APPROVAL
USER REQUIREMENTS ACCOMMODATION
CUP
SCP
STATION RESOURCE PROJECTION UPDATES
UCP
INTEGRATED USER PLANNING
OPS ORG'S
COMPATIBILITY ASSESSMENTS
TOP
SSUB
USER RQMTS
UTILIZATION OPS PANEL
USERS
SHUTTLE STATUS
RESOURCE STATUS
UTILIZATION STATUS
STS
SSSC
POIC
DATA SYSTEMS
LOC
TDRSS STATUS
LOGISTICS STATUS
TYPICAL DATA
• SPACE SYSTEMS RESOURCE AVAILABILITY
• APPROVED PAYLOADS
• TRANSPORTATION SYSTEMS AVAILABILITY
• DATA SYSTEMS AVAILABILITY
• GROWTH PLANS
• CREW SKILL NEED PROJECTIONS
TYPICAL DATA
• LAUNCH VEHICLE PLANNING
• LOGISTICS PLANNING
• INCREMENT P/L MANIFESTS
• CARGO PROCESSING REQUIREMENTS
• TRAINING PLAN
• SOFTWARE CHANGES

Figure III-9 Strategic And Tactical Planning Process Flow

## *KEY FEATURES OF THE TACTICAL OPERATIONS PLAN*

- *The CUP is the primary source document used in TOP development*
- *The manned base TOP is the "top" level planning document pertaining to specific increment utilization and operations.*
- *The TOP is a product of and is controlled by the Program Integration level of operations management.*
- *The TOP's principal function is to serve as an increment requirements or "manifest" document which defines key utilization and operations planning elements (payloads, ORUs, growth systems, etc.) and Program milestones associated with each increment over the next two-year period of manned base operations.*
- *User inputs supporting TOP development are provided through the various Payload Accommodation Managers (PAMs). (See below.)*
- *The TOP highlights logistics, transportation systems, and communication and data services requirements as a key determinant in manned base manifesting and operations capability.*
- *The TOP provides the required data to enable increasingly detailed planning for specific increment activities to be performed by Program Integration and Program Execution level personnel.*
- *Inputs to the TOP include:*
    - *Consolidated Utilization Plan*
    - *Two-year operations budgets*
    - *Two-year development schedules*
    - *User operations support analyses*
    - *Sustaining engineering assessments*
    - *System maintenance schedules*
    - *Engineering change requests*
    - *Safety assessments*
    - *Training and simulation facility requirements*
    - *Crew utilization policy*
    - *Accounting and control guidelines*
    - *Transportation operations schedules*
    - *Data Systems operations schedules*
- *TOP data typically might include:*
    - *Two-year operations schedules by increment*
    - *Two-year overview of payloads by increment*
    - *Trajectory management data*
    - *Transportation flight assignments*
    - *Systems configuration and operations protocol changes by increment*

## *THE ROLE OF THE PAYLOAD ACCOMMODATIONS MANAGER (PAM)*

*A Payload Accommodation Manager is assigned to each user selected under the CUP for participation in the SSP. The PAM's primary responsibility is to serve as the user's advocate to the Program, and to facilitate the user's interactions with all operational aspects of the Program. The PAM will be assigned upon initial acceptance of the user and provide support through post-flight acquisition of all required data and hardware. Each PAM will have the responsibility for coordinating the completion of required payload integration documentation (e.g., Payload Integration Plan) with assigned users. PAMs will be provided by NASA and each international partner, and will generally have a utilization-oriented background.*

## *TACTICAL UTILIZATION AND OPERATIONS PLANNING SUBFUNCTIONS*

*Within the Tactical Utilization and Operations Planning function are a number of iterative subfunctions which are required to develop increment assignments. (Reference Figure III-8.) The tactical operations planning function must balance these to develop the TOP:*

- *User Support Planning: Provided by the Utilization Control Panel (UCP), this function develops current and future user requirements for integration into the TOP.*
- *Transportation and Logistics Resource Planning: Provided by the transportation systems organizations and the Program's Logistics Operations Center, these organizations develop transportation and logistics support requirements, arrange for transportation, and determine ground support capability constraints.*
- *Systems Operations and Maintenance Planning: Provided by the Systems Control Panel (SCP), these functions develop incremental integrated manned base systems maintenance requirements, provisioning requirements, manned base resource availabilities, and optional manned base enhancement requirements.*
- *Safety Planning: Developed by the Program and reviewed and approved by independent safety review panels, this function establishes safety control procedures, plans and guidelines for inclusion in the TOP, and oversees development of safety requirements.*

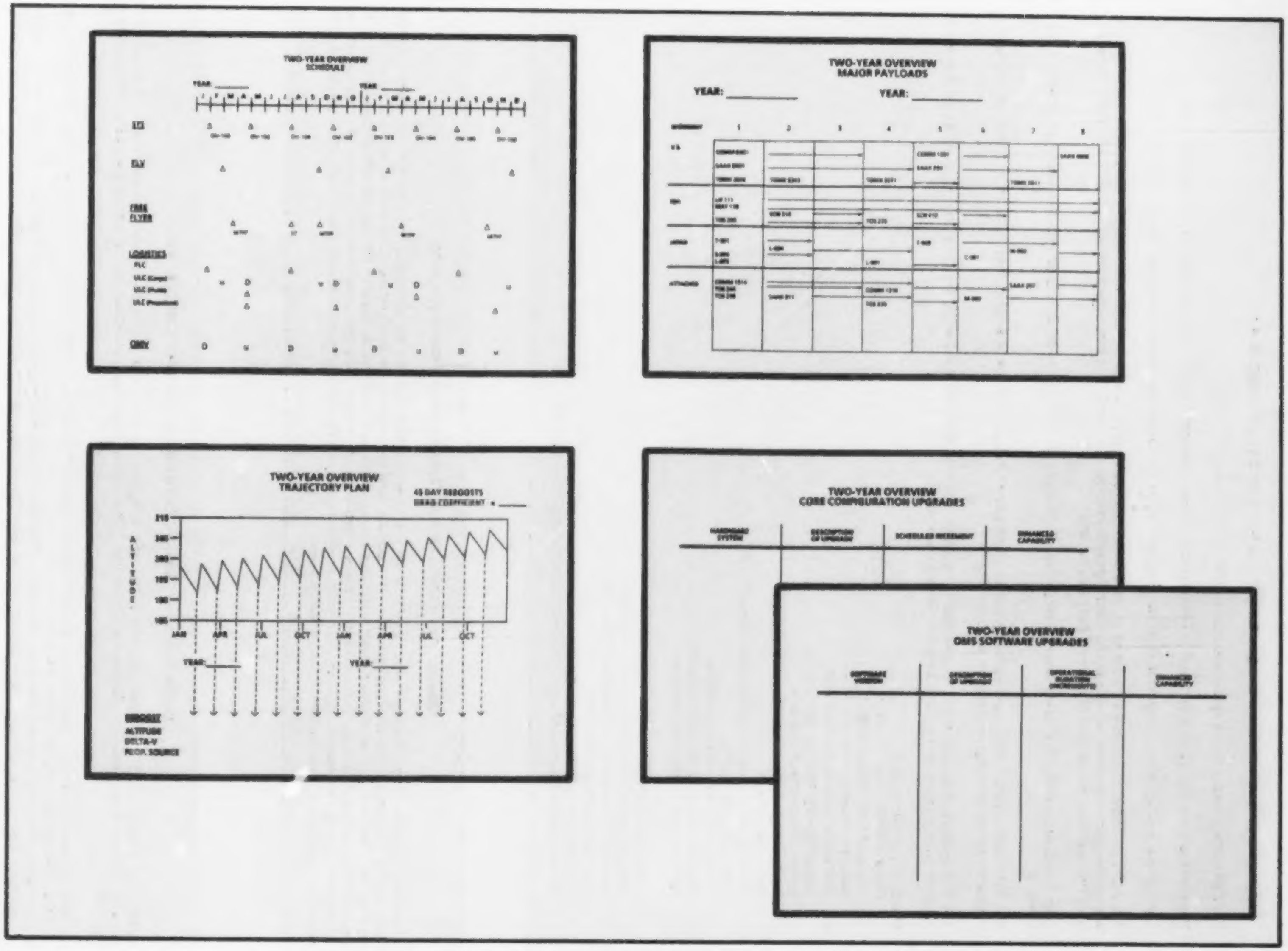
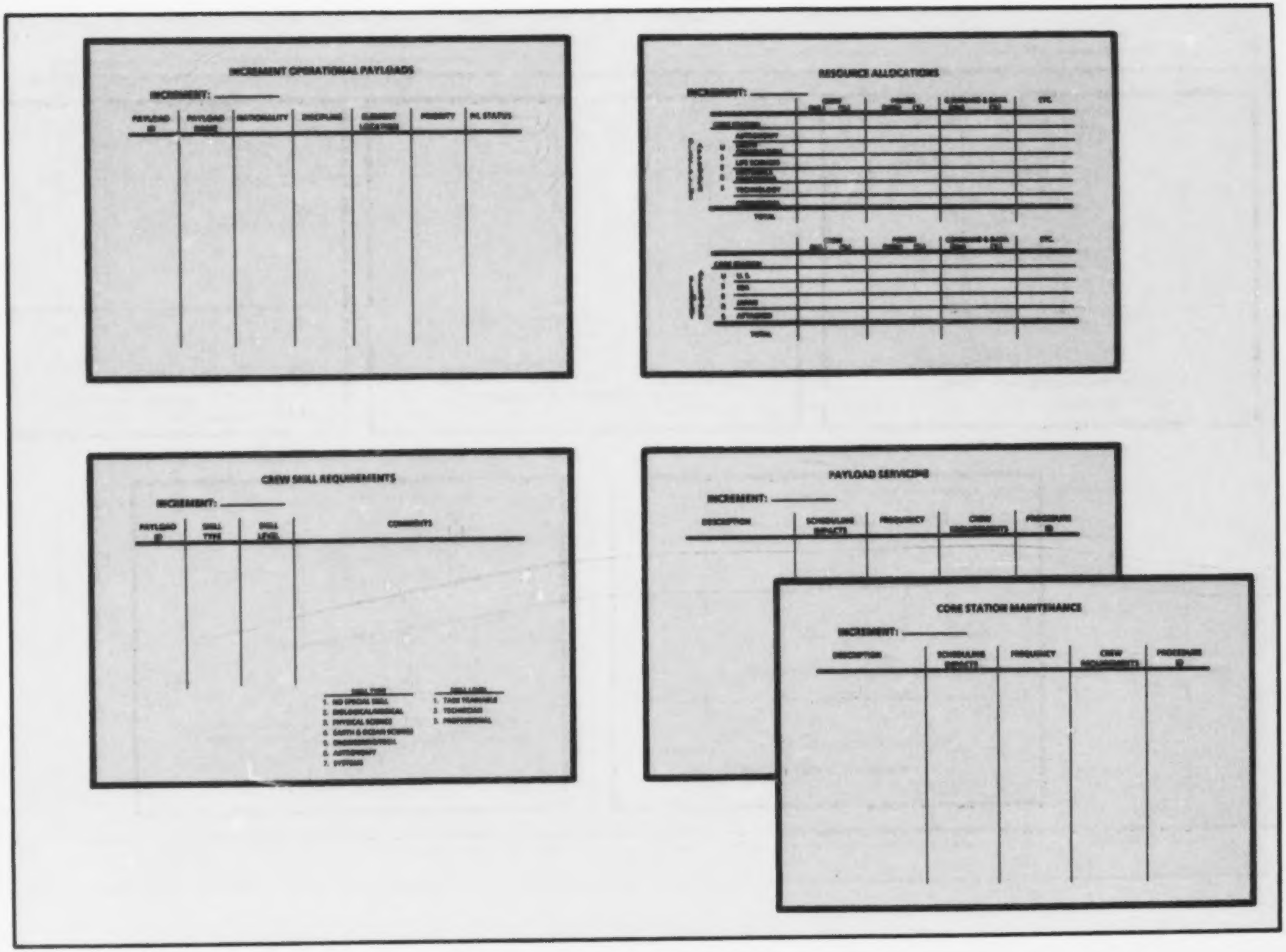

TWO-YEAR OVERVIEW
SCHEDULE
YEAR:
YEAR:
STS
ELV
FREE FLYER
LOGISTICS
PLC
ULC (Cargo)
ULC (Fluids)
ULC (Propellant)
OMV
TWO-YEAR OVERVIEW
MAJOR PAYLOADS
YEAR:
YEAR:
1
2
3
4
5
6
7
8
U.S.
JAPAN
ATTACHED
TWO-YEAR OVERVIEW
TRAJECTORY PLAN
45 DAY REBOOSTS
DRAG COEFFICIENT =
215
200
185
ALTITUDE
JAN
APR
JUL
OCT
JAN
APR
JUL
OCT
YEAR:
YEAR:
REBOOST
ALTITUDE
DELTA-V
PROP. SOURCE
TWO-YEAR OVERVIEW
CORE CONFIGURATION UPGRADES
HARDWARE SYSTEM
DESCRIPTION OF UPGRADE
SCHEDULED INCREMENT
ENHANCED CAPABILITY
TWO-YEAR OVERVIEW
OMS SOFTWARE UPGRADES
SOFTWARE VERSION
DESCRIPTION OF UPGRADE
OPERATIONAL DURATION (INCREMENTS)
ENHANCED CAPABILITY

Table III-5  Tactical Operations Plan: Two-Year Overview (Typical)



INCREMENT OPERATIONAL PAYLOADS

INCREMENT: ________

| PAYLOAD ID | PAYLOAD NAME | NATIONALITY | DISCIPLINE | ELEMENT LOCATION | PRIORITY | PL STATUS |
|---|---|---|---|---|---|---|

RESOURCE ALLOCATIONS

INCREMENT: ________

| | CREW | POWER | COMMAND & DATA | ETC. |
|---|---|---|---|---|
| CORE STATION | | | | |
| LIFE SCIENCES | | | | |
| TECHNOLOGY | | | | |
| TOTAL | | | | |

| | CREW | POWER | COMMAND & DATA | ETC. |
|---|---|---|---|---|
| CORE STATION | | | | |
| U.S. | | | | |
| ESA | | | | |
| JAPAN | | | | |
| AFFILIATED | | | | |
| TOTAL | | | | |

CREW SKILL REQUIREMENTS

INCREMENT: ________

| PAYLOAD ID | SKILL TYPE | SKILL LEVEL | COMMENTS |
|---|---|---|---|

SKILL TYPE
1. NO SPECIAL SKILL
2. BIOLOGICAL/MEDICAL
3. PHYSICAL SCIENCE
4. EARTH & OCEAN SCIENCE
5. ENGINEERING/TECHNICAL
6. ASTRONOMY
7. SYSTEMS

SKILL LEVEL
1. TASK TRAINABLE
2. TECHNICIAN
3. PROFESSIONAL

PAYLOAD SERVICING

INCREMENT: ________

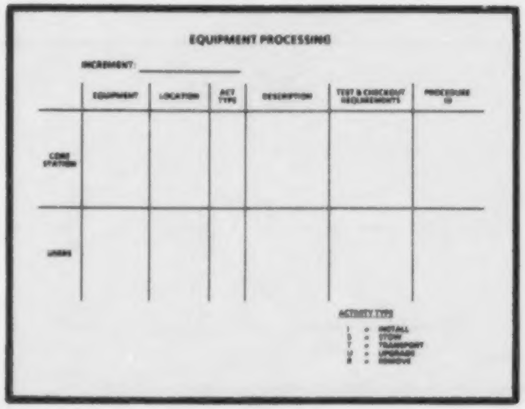
| DESCRIPTION | SCHEDULING IMPACTS | FREQUENCY | CREW REQUIREMENTS | PROCEDURE ID |
|---|---|---|---|---|

CORE STATION MAINTENANCE

INCREMENT: ________

| DESCRIPTION | SCHEDULING IMPACTS | FREQUENCY | CREW REQUIREMENTS | PROCEDURE ID |
|---|---|---|---|---|

Table III-6 Flight Increment Plan: Increment - Specific Data (Typical)



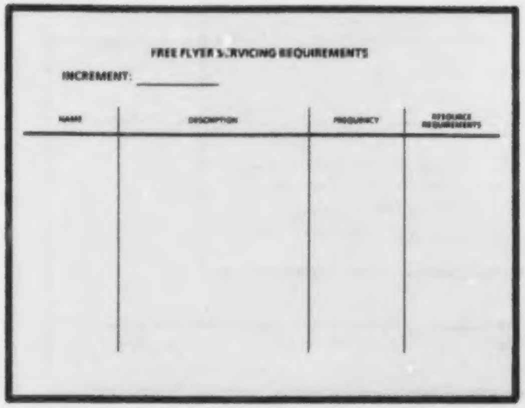
EQUIPMENT PROCESSING

INCREMENT: ______________

| | EQUIPMENT | LOCATION | ACT TYPE | DESCRIPTION | TEST & CHECKOUT REQUIREMENTS | PROCEDURE ID |
|---|---|---|---|---|---|---|
| CORE STATION | | | | | | |
| USERS | | | | | | |

ACTIVITY TYPE

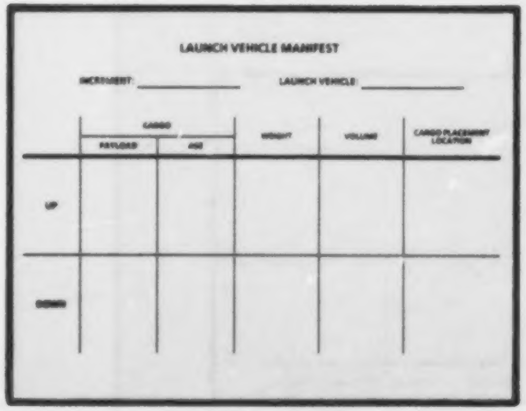
I = INSTALL
S = STOW
T = TRANSPORT
U = UPGRADE
R = REMOVE



FREE FLYER SERVICING REQUIREMENTS

INCREMENT: ______________

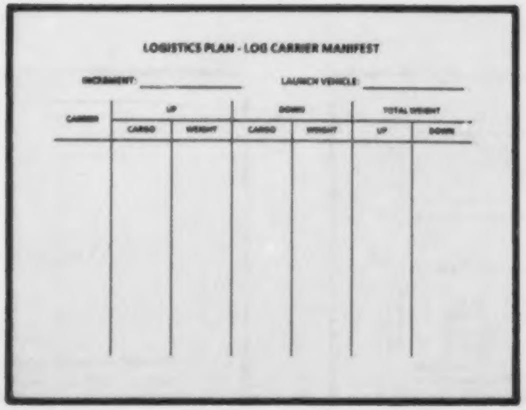
| NAME | DESCRIPTION | FREQUENCY | RESOURCE REQUIREMENTS |
|---|---|---|---|
| | | | |



LAUNCH VEHICLE MANIFEST

INCREMENT: ______________ LAUNCH VEHICLE: ______________

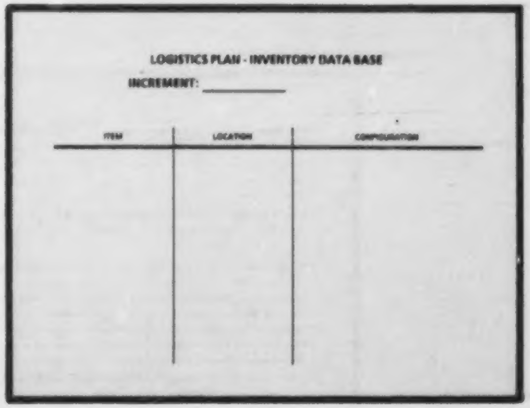
| | CARGO | | WEIGHT | VOLUME | CARGO PLACEMENT LOCATION |
|---|---|---|---|---|---|
| | PAYLOAD | ASE | | | |
| UP | | | | | |
| DOWN | | | | | |



LOGISTICS PLAN - LOG CARRIER MANIFEST

INCREMENT: ______________ LAUNCH VEHICLE: ______________

| CARRIER | UP | | DOWN | | TOTAL WEIGHT | |
|---|---|---|---|---|---|---|
| | CARGO | WEIGHT | CARGO | WEIGHT | UP | DOWN |
| | | | | | | |



LOGISTICS PLAN - INVENTORY DATA BASE

INCREMENT: ______________

| ITEM | LOCATION | CONFIGURATION |
|---|---|---|
| | | |

Table III-6 Flight Increment Plan: Increment - Specific Data (Typical) (Continued)

**UNIQUE STS CREW REQUIREMENTS**

**INCREMENT:** ____________

| TASK | DESCRIPTION |
|---|---|

**LAUNCH VEHICLE/STATION RESOURCE TRANSFER REQUIREMENTS**

**INCREMENT:** ____________

| RESOURCE | SOURCE | DESTINATION | QUANTITY | FREQUENCY |
|---|---|---|---|---|

**OMS REQUIREMENTS**

**INCREMENT:** ______________

- SOFTWARE RECONFIGURATION REQUIREMENTS, SUCH AS:
  - PAYLOAD PRIORITY TABLES
  - SCHEDULING RULES

**CARGO PROCESSING**

**INCREMENT:** _______________

- LAUNCH/LANDING PROCESSING REQUIREMENTS (FOR USE BY KSC), SUCH AS:
  - UNIQUE PRE-FLIGHT TESTING
  - LATE ACCESS REQUIREMENTS
  - POWER REQUIREMENTS
  - UNIQUE POST-FLIGHT HANDLING REQUIREMENTS

Table III-6 Flight Increment Plan: Increment - Specific Data (Typical) (Continued)

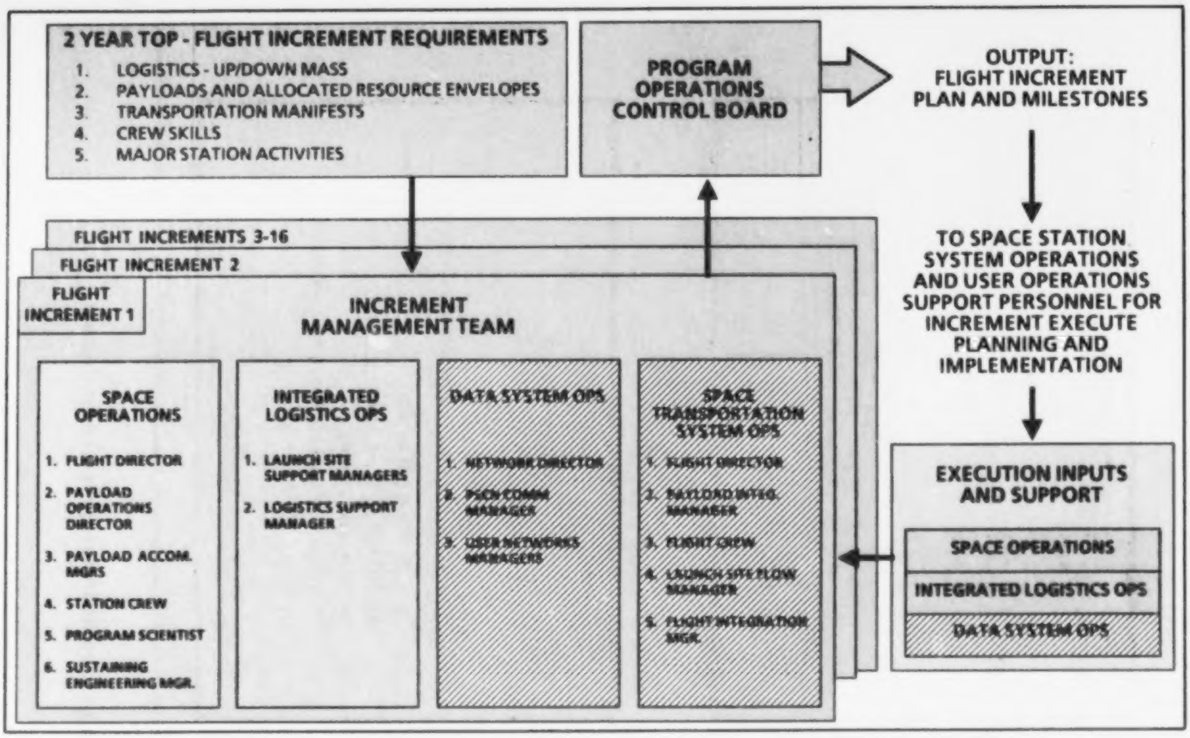

2 YEAR TOP - FLIGHT INCREMENT REQUIREMENTS
1. LOGISTICS - UP/DOWN MASS
2. PAYLOADS AND ALLOCATED RESOURCE ENVELOPES
3. TRANSPORTATION MANIFESTS
4. CREW SKILLS
5. MAJOR STATION ACTIVITIES
PROGRAM OPERATIONS CONTROL BOARD
OUTPUT: FLIGHT INCREMENT PLAN AND MILESTONES
TO SPACE STATION SYSTEM OPERATIONS AND USER OPERATIONS SUPPORT PERSONNEL FOR INCREMENT EXECUTE PLANNING AND IMPLEMENTATION
FLIGHT INCREMENTS 3-16
FLIGHT INCREMENT 2
FLIGHT INCREMENT 1
INCREMENT MANAGEMENT TEAM
SPACE OPERATIONS
1. FLIGHT DIRECTOR
2. PAYLOAD OPERATIONS DIRECTOR
3. PAYLOAD ACCOM. MGRS
4. STATION CREW
5. PROGRAM SCIENTIST
6. SUSTAINING ENGINEERING MGR.
INTEGRATED LOGISTICS OPS
1. LAUNCH SITE SUPPORT MANAGERS
2. LOGISTICS SUPPORT MANAGER
DATA SYSTEM OPS
1. NETWORK DIRECTOR
2. PSCN COMM MANAGER
3. USER NETWORKS MANAGERS
SPACE TRANSPORTATION SYSTEM OPS
1. FLIGHT DIRECTOR
2. PAYLOAD INTEG. MANAGER
3. FLIGHT CREW
4. LAUNCH SITE FLOW MANAGER
5. FLIGHT INTEGRATION MGR.
EXECUTION INPUTS AND SUPPORT
SPACE OPERATIONS
INTEGRATED LOGISTICS OPS
DATA SYSTEM OPS

**Figure III-10 Manned Base Operations Framework Increment Planning**

The IMT process for developing the FIP follows the CUP and TOP methodology: systems support requirements are first allocated from total available resources; the remaining resources are then allocated to specific payloads according to TOP guidelines. IMT members represent the various aspects of operations at the Program Integration and Program Execution levels. Each member serves as liaison between the IMT and the areas of operational expertise that member represents. Thus, institutional resources are available for conducting detailed technical analyses on space systems and payload systems hardware and software (or on purely operational considerations such as flight techniques) as necessary to facilitate an effective overall plan for integrated increment operations.

Planning for user activities associated with each increment is developed by the POIC consistent with the TOP and guidelines developed through the Investigators Working Group (IWG). The IWG is composed of those users (or their sponsors) represented on the specific flight increment. (I.e., there is a corresponding IWG for each increment.) The IWG and the PAMs insure that user interests are maintained in the increment planning process.

The draft FIP will be reviewed and approved by the various operations organizations. These organizations will verify increment-to-increment compatibility, as well as direct the independent safety reviews. Upon approval of the FIP, the SE&I office at NASA Headquarters will arrange procurement of transportation and data systems capability, and development of logistics support plans by the Space Transportation Systems, Data Systems Operations and Logistics Resource planning functions. Once the FIP is approved, the Increment Change Manager is responsible for ensuring that the execute planning and implementation tasks on the "critical path" are completed on schedule.[36]

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[36] *The Increment Change Manager has the authority to redirect the efforts of the various institutional support functions in the interest of accomplishing the requisite activities for an on-time launch and start of the onboard flight activities.*

### KEY FEATURES OF INCREMENT PLANNING

- *The primary emphasis of Increment Planning is on Program Integration level planning for ground and onboard configuration and operations changes to be implemented during each increment.*
- *Increment management is centralized at the Program Integration level with actual performance of many planning support functions distributed to the implementing operations centers or partner sites.*
- *The Increment Change Manager leads this process and with supporting IMT members, formulates and integrates operations policies and preparations across the Program for all configuration and operations changes which affect the assigned increment.*
- *Each increment's Flight Increment Plan (FIP) will contain increment-specific operations information pertaining to the preparation for and execution of manned base activities during that increment, and will serve as a "template" authorizing overall ground and onboard personnel and equipment resource utilization.*
- *Although planning for each flight increment at the FIP level is a separately managed activity, it must be closely coordinated with subsequent Increment Change Managers as well as with Program Execution level personnel engaged in scheduling and executing the current increment's orbital activities.*
- *Users are represented by their Payload Accommodation Manager (PAM) for all increment activities. (I.e., no separate user integration process is required for transportation systems support).*
- *The Increment Planning process continues through handover to the Program Execution level personnel for detailed increment execute planning and data preparation and implementation.*
- *During periods of increment execution, the Increment Change Manager serves as a consultant to the SSSC Flight Director and POIC Payload Operations Director as required to effectively replan operations activities in real-time.*
- *Inputs to the FIP include:*
  - *Payload manifest*
  - *Payload/systems resource allocations*
  - *Crew skill requirements*
  - *Manned base maintenance requirements*
  - *Payload servicing requirements*
  - *Equipment processing requirements*
  - *Platform servicing requirements*
  - *Launch vehicle manifest*
  - *Logistics plans*
  - *Unique data system requirements*
  - *Unique STS crew requirements*
  - *Onboard and ground system flight initialization data*
  - *Draft payload operations schedules*
  - *Cargo processing requirements*
  - *Crew training requirements*
- *FIP data typically might include:*
  - *Critical path schedules*
  - *Manifested payload priorities & key sequences*
  - *Systems & payloads resource allocations*
  - *Crew skill requirements summary*
  - *Servicing & maintenance requirements*
  - *Up/down transportation system manifests*
  - *Transportation system schedule & performance*
  - *Ground & onboard hardware & software upgrade/reconfiguration data*

### INCREMENT TEAM ROLES

*The Increment Management Teams draw on the support of the following members during the increment planning process:*

- *Manned Base and STS Flight Directors (FDs): Provide an integrated set of Station and STS space systems operations and maintenance requirements and priorities; safety concerns; integrated systems and user requirements; and crew training requirements and schedules.*
- *Payload Operations Director (POD): Provides an integrated set of user operations and servicing requirements and priorities.*
- *Payload Accommodation Manager (PAM): Coordinates individual user transportation, operations and servicing requirements.*
- *Station and STS Crews: Provide expertise on manned base systems and crew capabilities and knowledge of user objectives.*
- *Program Scientist (PS): Provides science community goals and priorities as well as utilization advice.*
- *Sustaining Engineering Manager: Provides current space systems performance status; scheduled maintenance expertise; resource allocation methodology; and an integrated set of transportation system accommodations.*
- *Station Launch Site Support Manager, STS Launch Site Flow Manager, and key processing team representatives: Provide an integrated set of prelaunch and postlanding processing operations, maintenance and servicing requirements; schedule requirements; and STS cargo handover requirements.*
- *Logistics Support Manager: Provides an integrated set of logistics support requirements and the logistics management plan.*
- *Network Director (ND) and key data system team representatives: Provide NASA space and ground network status and capabilities (TDRSS Space Network, Ground Network, and NASA Communications Network); and special data handling requirements.*
- *STS Payload Integration Manager (PIM): Provides STS requirements for Station logistics carrier hardware.*
- *STS Flight Integration Manager (FIM): Provides STS manifest integration requirements.*

### III.B.2.d. Increment Execute Planning

Increment Execute Planning is a Program Execution level function encompassing the development of execute plans and procedures which enable crew and ground support personnel to perform increment operations in real-time. This includes the detailed planning of operations and utilization execution plans (in particular the Increment Operations Plan--IOP)[37], and real-time replanning of operations in response to contingencies or new opportunities. Execution plans, procedures, schedules and related data are derived from the relevant FIP and developed at this planning level by the responsible operations support centers.

The Increment Execute Planning process directly supports the continued "maintenance" of the parent FIP. For example, as the detailed planning process evolves and the impacts of integration of manifested user and manned base systems activities becomes more apparent, it may become necessary to redirect certain systems or payload activities, either in priority or order of accomplishment or, in extreme cases, to reassign them to another increment. Thus, an effective increment planning process is a continuum involving the IMT as well as the increment execute planning team.

Figure III-11 provides an illustration of the interrelated nature of the Increment Planning, Increment Execute Planning and Real-time Operations functions. At this level, distinctions between Program Integration and Execution level activities become blurred as the degree of functional overlapping increases (especially for payloads which remain on orbit for multiple increments or for maintenance and servicing tasks which bridge increments). The centralized management aspects of the Recommended Framework strengthen the smooth flow of plans and information between the management levels of the Program, while the distributed execution planning aspects allow flexibility to support independent user operations planning.

**KEY FEATURES OF INCREMENT EXECUTE PLANNING**

*Execute Plans and Data: Following the inclusion of an increment in the TOP and the subsequent development of that increment's FIP by the Increment Management Team, the execute teams at the various support centers begin preparation of the multitude of ground support and flight products which are derived from the source FIP and are required to actually implement the increment operations. Execute plans and data provide technical direction in preparation for and implementation of real-time support to onboard operations involving space systems and payload activities. These data support nominal and contingency operations, and typically include such items as: an Increment Operations Plan (IOP) which provides the crew with detailed timelines for the transfer operations period of the increment; an Increment Hazard Control Plan (IHCP) which identifies systems and payload operations which require special operations precautions during preparation and/or operation; detailed schedules which trace the flow of hardware through the SSPF in preparation for flight; manifests of equipment to be taken to and from the Station elements using the appropriate transportation system; increment-specific crew training plans; and the Flight Data File (FDF) complement of procedures and data developed and verified to support execution of systems and payload operations onboard the manned base. Most execute plans and data will reside in electronic data bases and will be available to each U.S. and partner support center.*

- *Management of Increment Execute Planning is distributed at the Program Execution level with actual performance of detailed planning support functions the responsibility of the implementing operations centers or partner sites.*
- *Inputs to the increment execute planning process provided by the FIP typically include:*
    - *Critical path schedules*
    - *Manifested payload priorities & key sequences*
    - *Systems & payloads resource allocation data*
    - *Crew skill requirements summary*
    - *Servicing & maintenance requirements*
    - *Up/down transportation system manifests*
    - *Transportation system schedule & performance data*
    - *Ground & onboard hardware & software upgrade/reconfiguration data*
- *Increment execute products typically include:*
  *Space operations:*
    - *Increment operations Plan (IOP-approximately two weeks of detailed planning involving transfer operations associated with STS or ELV resupply missions)*
    - *Space Systems operations and Maintenance Procedures*
    - *Payload operations Procedures (user supplied)*
    - *Payload Servicing Procedures (NASA supplied)*
    - *Supporting Data, Maps, Charts, etc.*

  *Space Operations Support:*
    - *Support Center Hardware & Software Reconfiguration Schedules & Data*
    - *Increment Hazard Control Plan*
    - *Mission Rules*
    - *Console Handbooks & Ground operator Procedures*
    - *Personnel Support Plans & Schedules*
    - *SSSC Interface Protocols*
    - *Transportation & Data Systems Interface Protocols*
    - *Onboard Data Configuration Control Methodology*
    - *Increment Specific Crew Training Plans*
    - *Onboard Anomaly Logs*
    - *Space Systems Maintenance Procedures*
    - *Space Systems Sustaining Engineering Data*

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[37] *The IOP provides detailed activity timelines for the two-week period of transfer operations only when the Shuttle is visiting the manned base.*

***KEY FEATURES OF INCREMENT EXECUTE PLANNING (CONTINUED)***

***Logistics Operations Support:***
- ***Integrated Flight Hardware Processing Schedules & Support Data***
- ***"Flight Line" Test & Checkout Procedures***
- ***Transportation System Interface Procedures***
- ***Integrated Logistics Systems Data including:***
  ***Schedules, Ground operations & Maintenance Requirements & Procedures, Ground Personnel Training Plans, onboard Stowage Maps, ORU Configuration & Maintenance Histories, etc.***

### III.B.2.e. Operations Execution

The Framework for real-time manned base operations management centers on five operations functions: launch site operations support (coordinated by the Logistics Operations Center and the Space Station Processing Facility); manned base systems operations support (coordinated by the Space Station Support Center), payload operations integration support (coordinated by the Payload Operations Integration Center); crew training and operations support (coordinated by the Space Station Support Center with support from the POIC); and general engineering support (supplied by the Engineering Support Centers). Together these functions (1) maintain a safe and consistent environment for the execution of crew operations (both systems and payload); and (2) maximize the returns from user payload operations. Figure III-12 illustrates the interrelationships among these functions.

- **Logistics Operations Support**

Logistics operations support functions include two primary types of operations activities: 1) integrated logistics operations performed at the launch site in a dedicated Program facility, and 2) prelaunch and postlanding processing of flight hardware performed at the launch site in a dedicated Program facility as well as at delegated remote user facilities.

Integrated logistics operations will be managed and performed by the Logistics Operations Center (LOC). The LOC integrates Program-wide logistics support requirements and provides inputs to all levels of the planning process. This facility will procure, repair and provide inventory management and supply support for an estimated 300,000 items, including 2500 orbital replacement units. The LOC will be responsible for configuration management of these items as well as the

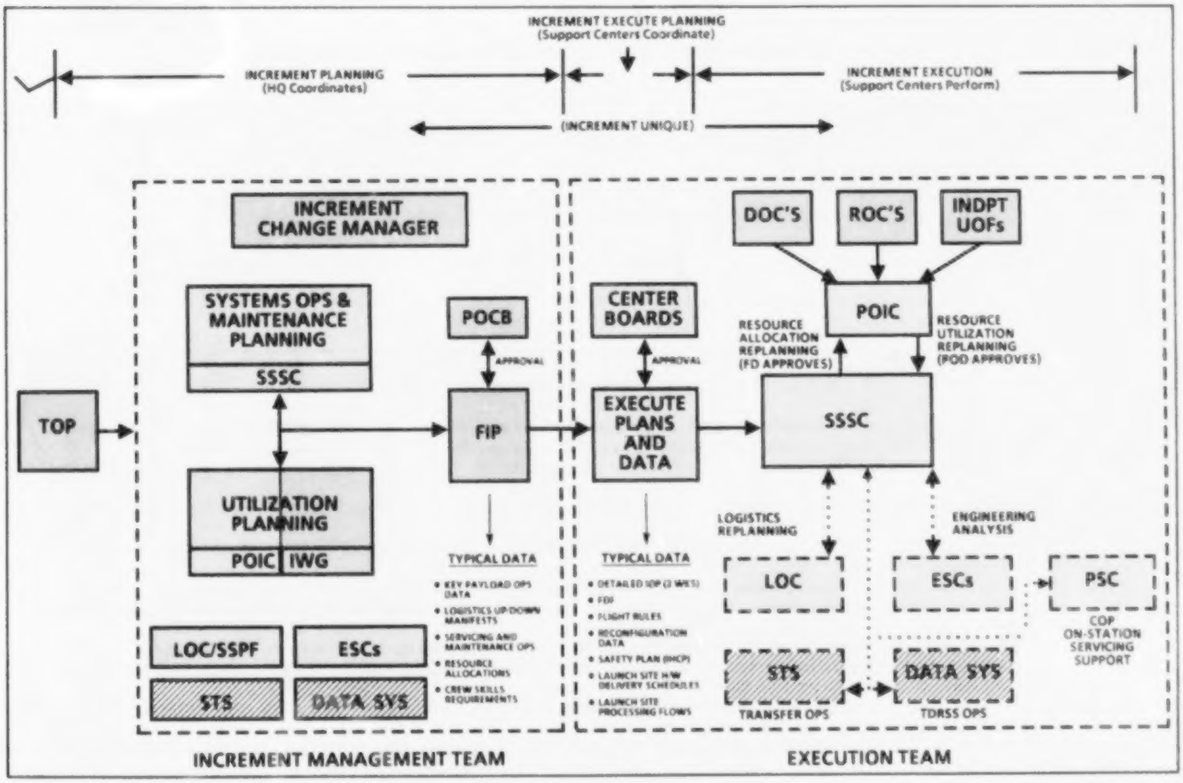
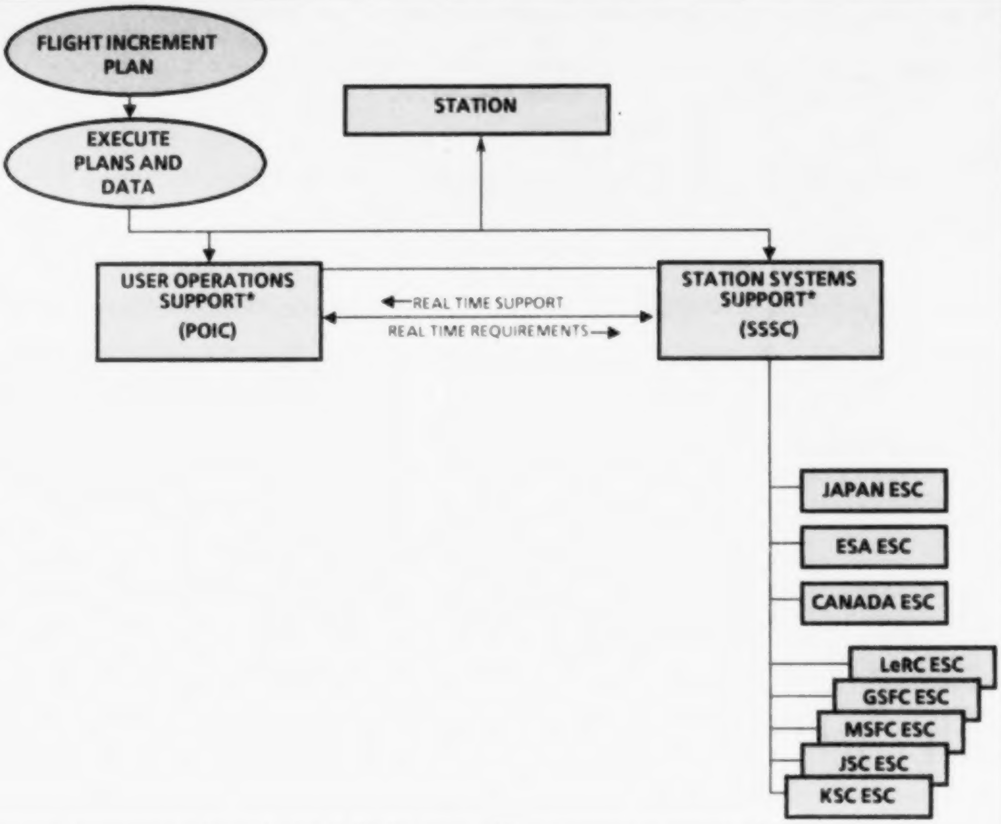

INCREMENT EXECUTE PLANNING
(Support Centers Coordinate)
INCREMENT PLANNING
(HQ Coordinates)
INCREMENT EXECUTION
(Support Centers Perform)
(INCREMENT UNIQUE)
INCREMENT CHANGE MANAGER
SYSTEMS OPS & MAINTENANCE PLANNING
SSSC
POCB
APPROVAL
TOP
FIP
UTILIZATION PLANNING
POIC
IWG
TYPICAL DATA
• KEY PAYLOAD OPS DATA
• LOGISTICS UP-DOWN MANIFESTS
• SERVICING AND MAINTENANCE OPS
• RESOURCE ALLOCATIONS
• CREW SKILLS REQUIREMENTS
LOC/SSPF
ESCs
STS
DATA SYS
INCREMENT MANAGEMENT TEAM
CENTER BOARDS
APPROVAL
EXECUTE PLANS AND DATA
TYPICAL DATA
• DETAILED IOP (2 WKS)
• FDF
• FLIGHT RULES
• RECONFIGURATION DATA
• SAFETY PLAN (HCP)
• LAUNCH SITE H/W DELIVERY SCHEDULES
• LAUNCH SITE PROCESSING FLOWS
DOC'S
ROC'S
INDPT UOFs
POIC
RESOURCE ALLOCATION REPLANNING (FD APPROVES)
RESOURCE UTILIZATION REPLANNING (POD APPROVES)
SSSC
LOGISTICS REPLANNING
ENGINEERING ANALYSIS
LOC
ESCs
PSC
COP ON-STATION SERVICING SUPPORT
STS
TRANSFER OPS
DATA SYS
TDRSS OPS
EXECUTION TEAM

Figure III-11 Increment And Increment Execute Planning Process Flow


FLIGHT INCREMENT PLAN
EXECUTE PLANS AND DATA
STATION
USER OPERATIONS SUPPORT* (POIC)
STATION SYSTEMS SUPPORT* (SSSC)
REAL TIME SUPPORT
REAL TIME REQUIREMENTS
JAPAN ESC
ESA ESC
CANADA ESC
LeRC ESC
GSFC ESC
MSFC ESC
JSC ESC
KSC ESC

* These operations incorporate launch site & flight crew office support as required

Figure III-12 Manned Base Operations Framework
Real-Time Operations--Systems Support

***KEY FEATURES OF REAL-TIME OPERATIONS EXECUTION***

- *Manned base systems support and payload operations integration activities are functionally distinct; the SSSC controls all systems operations and the POIC integrates the payload operations support requirements using the SSSC systems template.*
- *Off nominal (contingency) manned base systems situations are managed by the SSSC including the broad reallocation of affected resources.*
- *Contingency situations involving onboard payload operations are managed by the POIC without SSSC involvement if manned base systems or flight safety are not affected.*
- *All remote and on-site users interface exclusively with the POIC. With the exception of EVA activities, the SSSC is generally transparent to the user community.*
- *Users will develop their own operations procedures within NASA standards; the POIC will review and approve user procedures and verify safety precautions are included as stipulated in the Increment Hazard Control Plan and other Program safety documentation.*
- *Logistics and processing requirements are implemented through two facilities located at the launch site. The Logistics Operations Center (LOC) manages logistics operations functions, while the Space Station Processing Facility (SSPF) supports the pre/postflight space systems and user equipment processing flow.*
- *The SSSC shall assume overall responsibility for co-orbiting platform operations during maintenance and servicing missions conducted within the manned base's command and control zone.*
- *The POIC shall coordinate any joint platform and manned base support by working with appropriate user representatives and the SSSC.*

development of flight qualification criteria for each. Additionally, the LOC will coordinate requirements for ORU in-flight maintenance with the development centers and provide these to the Increment Management Team or SSSC, as appropriate, for incorporation into increment execute documentation. The LOC will be responsible for the development, validation and configuration control of logistics standards, logistics personnel training, acquisition of ground support equipment, and will assist in the development of resupply manifests.

The LOC will also oversee a uniform approach to the maintenance and upgrade of the institutional systems which support the Program. A key feature of the LOC will be extensive use of automated test equipment for in-house maintenance and repair.

Prelaunch and postlanding payload processing tasks will be shared by users and the Space Station Processing Facility (SSPF). Payload integration involves up to five different steps, with users performing the first two: (1) the build-up of a payload at the user's facility; (2) the integration of the payload into a payload rack or Payload Interface Adapter (PIA)[38] at Science and Technology Centers or regional operations facilities; (3) rack interface simulation and verification and rack-to-carrier integration performed by the SSPF; (4) carrier-to-launch vehicle integration performed by the Shuttle (or ELV) processing facilities; and (5) on-orbit installation and checkout by the crew and ground support personnel.

Prelaunch and postlanding operations begin with the selection and manifesting of a user to a Station increment, and carry through the return of products and/or hardware orbit. This will require extended user involvement (often on a multi-year basis), with the user's depth of involvement dependent on the nature of the user hardware and required interfaces with Station elements, payload carriers and the launch vehicle(s).

Program partners will also coordinate performance of the first two steps of the payload integration process through their regional operations facilities, and deliver the payloads they sponsor to the SSPF for final interface verification. For those users who do not have access to a S&T Center or regional operations facility, the SSPF will offer the necessary integration services. The integrated carriers will then be delivered to the STS or ELV processing organization for final integration into the launch vehicle. Provision will be made for late access or stowage on the pad (e.g., last minute delivery of biological materials) and early removal at landing sites of payloads from the Station logistics carriers.

In addition to user payload processing, the SSPF will be responsible for processing Space Station systems hardware prior to integration into a transportation vehicle (the STS, or ELVs if available).[39] These activities include the refurbishment and recertification (turnaround) of flight hardware (e.g., logistics carriers, payload racks, PIAs). The Station sustaining engineering function will oversee the requirements for recertifi-

**_KEY FEATURES OF LOGISTICS OPERATIONS SUPPORT_**

***Logistics operations support activities are managed at the launch site under the auspices of a Logistics Operations Center (LOC) and a Space Station Processing Facility (SSPF).***

- ***The LOC will be responsible for the development of the manned based increment maintenance plans and assuring that the procedures, tools and materials to support the increment maintenance plans are available to support the increment schedules.***
- ***The LOC will be responsible for storage, inventory management and maintenance of all Station system parts, orbital replacement units (ORUs) and payload carriers.***
- ***Early/late access to the manned base logistics module will be supplied for time-critical payloads.***
- ***The logistics operations support framework allows for the use of a mixed fleet to provide transportation support (including partner-supplied vehicles).***
- ***Final rack-to-Station interface verification and checkout will be performed at the Space Station Processing Facility (SSPF). Transportation vehicle integration will be performed by the transportation system processing organization(s).***
- ***Users will be able to perform payload-to-rack and PIA level integration through the establishment of Program-certified Science and Technology (S&T) Centers. Users would determine S&T Center organization and structure.***
- ***S&T Centers may serve as representatives of discipline science and technology user groups, and may be co-located at DOCs. Payload-to-rack and PIA integration would be performed consistent with Station safety and interface requirements. The SSPF will perform experiment integration to support users who do not have access to an S&T Center.***
- ***The Task Force recommends a staged transition from distributed management of sustaining engineering for U.S. orbiting elements at the development ESCs to a centralized organization at KSC. It is assumed that this transition will occur when operations characteristics have stabilized sometime in the mature operations phase of the Program.***

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[38] *A PIA is intended to support multiple external payloads, providing a single interface/attachment point to the manned base truss.*

[39] *Similar smaller facilities will exist at other launch sites as necessary (including partner sites).*

cation with implementation of these requirements by the launch site organization (under the auspices of the LOC).[40] The prelaunch and postlanding processing flows are presented in Figures III-13 and III-14.

The framework will accommodate the development of partner LOC's and SSPFs if and when foreign launch vehicles and launch sites are used to support the Station. In order to assure safety and system integrity, it is assumed that these facilities will have to adhere to the same basic standards and procedures as the KSC facilities, and "report" to the Program Integration level responsible for integrated logistics.

- **Manned Base Systems Operations Support**

During real-time operations, the SSSC (led by its Flight Director) is charged with maintaining manned base systems in working order and providing for the general health and welfare of the crew. SSSC responsibilities will include: space systems performance monitoring, resource availability assessments and projections, oversight of and support for increment changes, systems and user operations replanning,[41] systems maintenance, housekeeping templates, crew safety assurance, extravehicular activity (EVA) scheduling and support, trajectory and altitude maintenance, and command and control zone operations support (in conjunction with the STS Mission Control Center).[42]

In the interest of system safety and clear communications paths to the Station crew, the SSSC will perform overall management and control of the air-to-ground data and voice links, and will be responsible for coordination of Space Station systems flight data file uplinks to the crew (including checklists and crew timelines). The POIC will be responsible for coordinating specific user operation of the data and voice links for payload operations, consistent with SSSC operations guidelines and constraints.

The SSSC is also responsible for integration of all systems upgrade and sustaining engineering operations support provided by the various Engineering Support Centers (both domestic and partner supplied -- see again Figure III-12). The SSSC

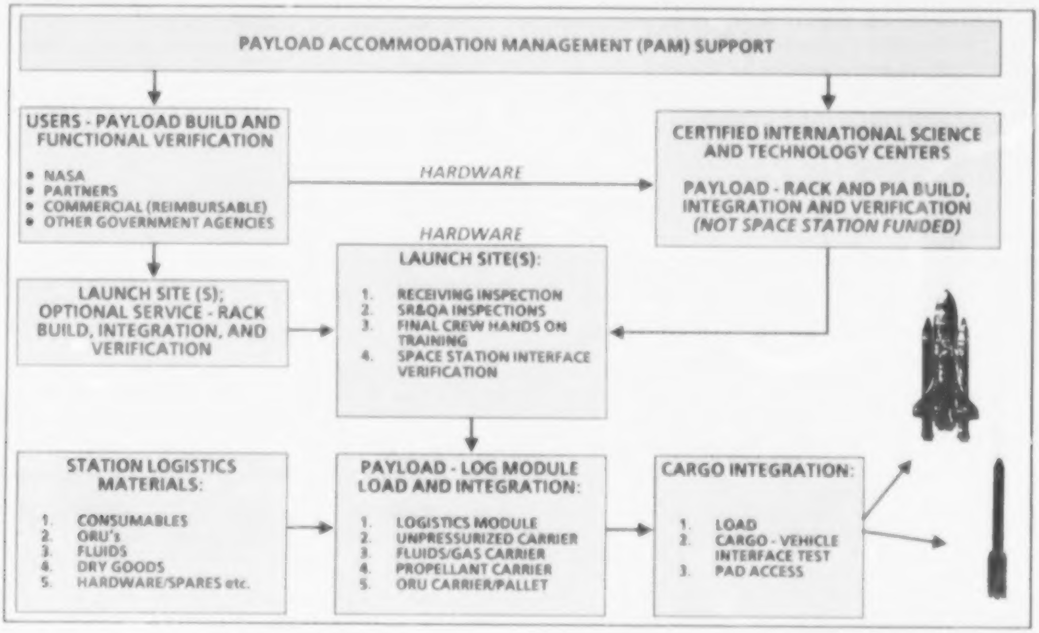
PAYLOAD ACCOMMODATION MANAGEMENT (PAM) SUPPORT
USERS - PAYLOAD BUILD AND FUNCTIONAL VERIFICATION
• NASA
• PARTNERS
• COMMERCIAL (REIMBURSABLE)
• OTHER GOVERNMENT AGENCIES
HARDWARE
CERTIFIED INTERNATIONAL SCIENCE AND TECHNOLOGY CENTERS
PAYLOAD - RACK AND PIA BUILD, INTEGRATION AND VERIFICATION
(NOT SPACE STATION FUNDED)
HARDWARE
LAUNCH SITE (S); OPTIONAL SERVICE - RACK BUILD, INTEGRATION, AND VERIFICATION
LAUNCH SITE(S):
1. RECEIVING INSPECTION
2. SR&QA INSPECTIONS
3. FINAL CREW HANDS ON TRAINING
4. SPACE STATION INTERFACE VERIFICATION
STATION LOGISTICS MATERIALS:
1. CONSUMABLES
2. ORU's
3. FLUIDS
4. DRY GOODS
5. HARDWARE/SPARES etc.
PAYLOAD - LOG MODULE LOAD AND INTEGRATION:
1. LOGISTICS MODULE
2. UNPRESSURIZED CARRIER
3. FLUIDS/GAS CARRIER
4. PROPELLANT CARRIER
5. ORU CARRIER/PALLET
CARGO INTEGRATION:
1. LOAD
2. CARGO - VEHICLE INTERFACE TEST
3. PAD ACCESS

Figure III-13 Prelaunch Hardware Flow
User Payloads And Station Logistics Materials

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[40] *Further details of the logistics support operations concept can be found in the Ground Operations Panel report.*

[41] *Real-time user replanning will be initiated by the IWG, and coordinated and approved by the Discipline Operations Team responsible for execution of that user operation and passed through the POIC to the SSSC.*

[42] *The manned base's command and control zone is the area within 20 nautical miles of the manned base in the fore and aft, top and down directions, and within five nautical miles in out-of-plane directions. Within this zone, the onboard crew maintains control authority of all manned spacecraft and an increased level of communication and tracking activity for STS visits.*

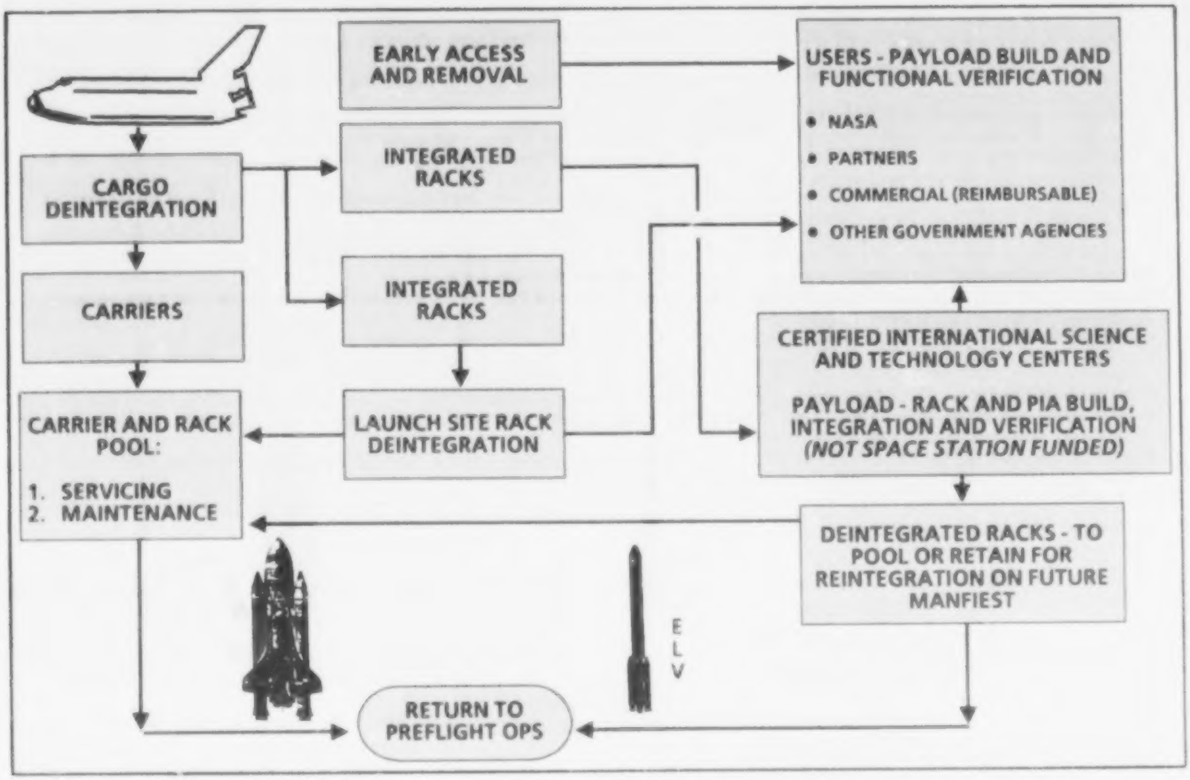

EARLY ACCESS AND REMOVAL
USERS - PAYLOAD BUILD AND FUNCTIONAL VERIFICATION
• NASA
• PARTNERS
• COMMERCIAL (REIMBURSABLE)
• OTHER GOVERNMENT AGENCIES
CARGO DEINTEGRATION
INTEGRATED RACKS
CARRIERS
INTEGRATED RACKS
CERTIFIED INTERNATIONAL SCIENCE AND TECHNOLOGY CENTERS
PAYLOAD - RACK AND PIA BUILD, INTEGRATION AND VERIFICATION (NOT SPACE STATION FUNDED)
CARRIER AND RACK POOL:
1. SERVICING
2. MAINTENANCE
LAUNCH SITE RACK DEINTEGRATION
DEINTEGRATED RACKS - TO POOL OR RETAIN FOR REINTEGRATION ON FUTURE MANFIEST
E L V
RETURN TO PREFLIGHT OPS

Figure [illegible] 14 Postlanding Hardware Flow
User Payloads And Station Logistics Materials

***LAUNCH SITE PROCESSING***

*The functions/responsibilities to be performed by the launch site in the implementation of prelaunch and postlanding operations include the following:*

- *Conduct ground operations reviews to assess/ correct payload problems;*
- *Develop ground integration/test procedures from payload element inputs;*
- *Perform payload physical integration/deintegration, where required;*
- *Receive payload integrated elements (racks, PIAs);*
- *Perform integrated payload mission testing on Station interface simulators for compatibility assessments and safety assurance;*
- *Perform integration/deintegration of Space Station logistics carriers;*
- *Perform Space Station logistics carrier/payload interface testing; and*
- *Integrate and verify Space Station logistics carriers to launch vehicles.*

integrates any plans for capabilities enhancements into the real-time operations allocations for systems maintenance versus user operations.

The SSSC will provide active support to the crew for at least one shift per day, with a minimum level of support consistent with safety requirements the remainder of the time. Extensive use of automated monitoring capabilities will help to keep personnel requirements to a minimum.

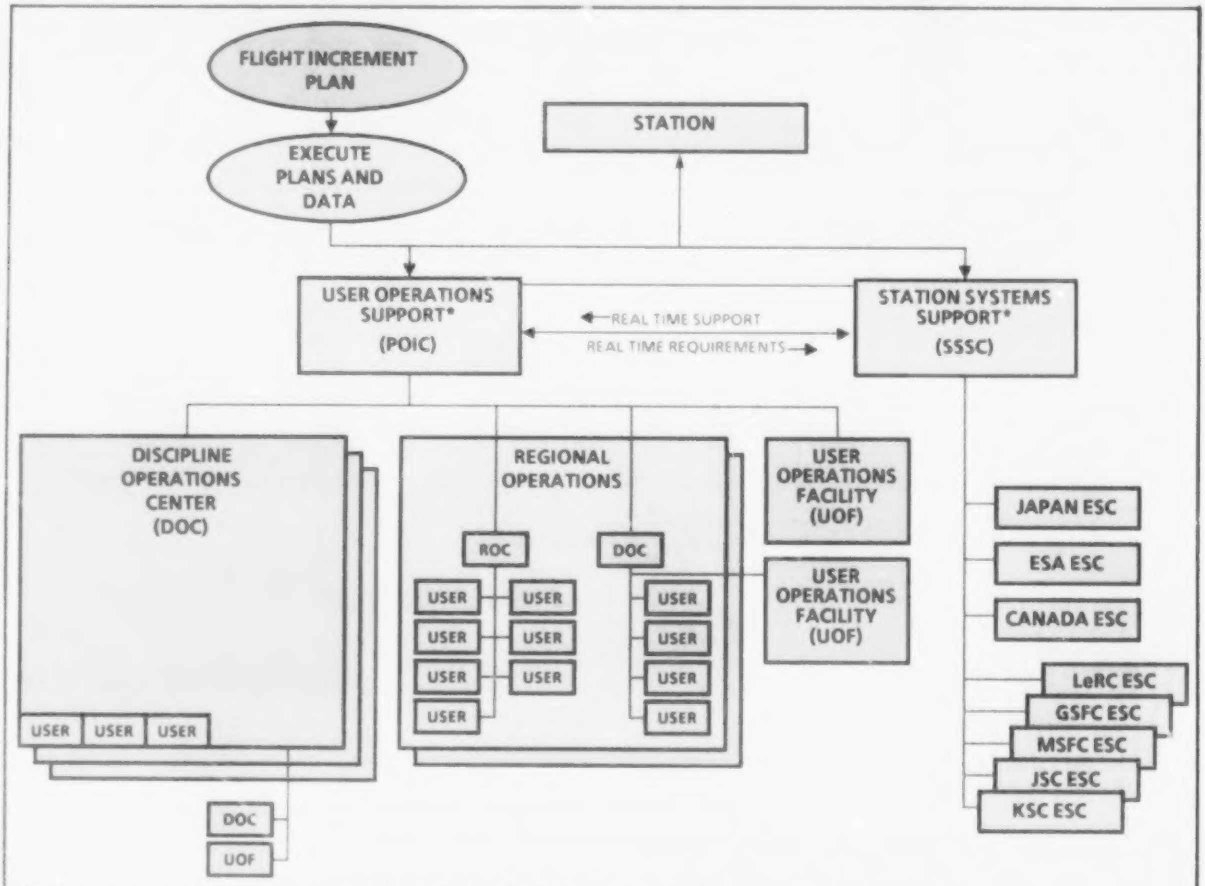
Other systems inputs are provided to the SSSC by the LOC for logistics support requirements, and by the Platform Support Center (PSC) for any transfer operations scheduling requirements for servicing of the Co-Orbiting Platform (COP). These inputs are integrated into the real time replanning effort, along with the user resource templates provided by the POIC to maximize systems performance, crew effectiveness, and user operations returns.

- Payload Operations Integration Support

The POIC (managed in real-time by the Payload Operations Director) will support manned base operations by providing the user operations requirements integration function for the various U.S. and partner-sponsored user support facilities which were previously described in Section I-D. (See Figure III-15.) This will involve the acquisition of all payload

***SSSC RESPONSIBILITIES***

- *Resource Availability Assessments: The SSSC provides resource availability templates to the POIC enabling user development of real-time execution plans.*
- *Resource Availability Projections: The SSSC provides resource availability projections to the Increment Management Teams (IMTs) working on subsequent FIPs. These projections represent the latest information available to the team since the last TOP was published. Projections are also made available to the Tactical Utilization and Operations Planning function for their use in building the TOP for the next two years of flight increments.*
- *Maintenance and Housekeeping Templates: The SSSC develops and maintains the standard maintenance and housekeeping template that reflects all routine systems operations and maintenance requirements.*
- *Systems Performance Monitoring and Analysis: The SSSC provides adjustments to the systems operations templates resulting from malfunctions or performance degradations as required by the crew and the POIC. Replanning efforts in the interest of maintaining payload user operations are considered and implemented as possible.*
- *Safety: The SSSC is responsible for the safe conduct of all manned base operations, both Station systems and user systems, including oversight of all hazard control plans.*
- *Extravehicular Activity (EVA): The SSSC manages all EVA procedure development and supports EVA operations.*
- *Trajectory and Altitude: The SSSC monitors the orbital status of the manned base and schedules trajectory and altitude adjustments (coordinated with the POIC to minimize impact on user operations).*
- *Command and Control Zone Operations Support: The SSSC is responsible for all planning and operations for operations involving EVA astronauts, OMV, FTS and platforms. STS berthing operations are directed by the SSSC, and coordinated with the STS Mission Control Center within the Station control zone.*
- *Uplink and Downlink: The SSSC provides overall up/down data and voice link management and control as it affects the configuration of space systems and supporting ground equipment.*


FLIGHT INCREMENT PLAN
EXECUTE PLANS AND DATA
STATION
USER OPERATIONS SUPPORT* (POIC)
REAL TIME SUPPORT
REAL TIME REQUIREMENTS
STATION SYSTEMS SUPPORT* (SSSC)
DISCIPLINE OPERATIONS CENTER (DOC)
USER
USER
USER
DOC
UOF
REGIONAL OPERATIONS
ROC
DOC
USER
USER OPERATIONS FACILITY (UOF)
USER OPERATIONS FACILITY (UOF)
JAPAN ESC
ESA ESC
CANADA ESC
LeRC ESC
GSFC ESC
MSFC ESC
JSC ESC
KSC ESC

* These operations incorporate launch site & flight crew office support as required

Figure III-15 Manned Base Operations Framework
Real-Time Operations--Systems And User Support

operations and servicing requirements to be performed onboard the manned base as well as at the launch and landing site. These may include operational requirements for transportation system interface (including launch environment constraints), payload setup or assembly, resource allocation, prelaunch/postlanding/orbital servicing, transportation system/manned base stowage, data collection and distribution, and teardown/return. The POIC will then assist users in the evolution of these requirements into end-to-end payload increment operations plans, procedures and schedules which are safe and which satisfy Program design and operations criteria. The SSSC will provide resource availability templates (including data uplink/downlink constraints) or "utilization windows" to the POIC to facilitate integrated user planning. The POIC will work with the IWG to optimally schedule user activities within these windows. The resultant plan for increment user operations will be returned to the SSSC for final integration with space systems, data systems and onboard crew activities and for publication of the Integrated Operations Plan for that increment.

Additionally, the POIC will interface as required with the launch site to assist in the development and integration of related payload requirements into logistics operations support plans and prelaunch and postlanding processing operations plans.

Lastly, the POIC provides real-time support to the accomplishment of these requirements by Program support and user personnel. POIC personnel will support the IWG and manage the daily flow of user-to-user and user-to-manned base interfaces. The POIC will arbitrate resolution of conflicts regarding unscheduled/rescheduled payload operations, operations priorities, payload resource allocations, etc., and will represent the user to the SSSC for resource allocation tradeoffs between space systems and payloads.

Should unforeseen schedule difficulties, resource constraints or technical anomalies occur in either payload or manned base systems operations, simultaneous and complementary real-time replanning support will be provided to the IWG and onboard crew by both the SSSC and POIC in order to ensure minimum disruption to planned and payload operations activity. It is anticipated that during the early portion of each increment, an iterative payload operations replanning effort is likely to be the rule rather than the exception. Additionally, should unforeseen targets of opportunity arise for collection of valuable scientific data (such as the observation of a supernova), the POIC will coordinate IWG requests for special resource allocation with the SSSC to make these temporary allocations available (as possible) in a timely fashion.[43]

SSSC trajectory and altitude data, voice and command link allocations resource allocation updates, and Station crew and systems status information will be continuously available through the POIC as an aid to user replanning and operations.

- **Crew Selection and Operations**

Crew selection is integral to the entire operations planning and execution process.[44] The SSOTF recommends that the astronaut selection, assignment and training be coordinated by the existing Astronaut Office located at the Johnson Space Center. The Station and the STS astronaut selection and training programs would be distinct, based on their differing training requirements. (See Figure III-16.)[45]

**POIC RESPONSIBILITIES**

*The Payload Operations Integration Center is a Program-supplied support service for the user community. It is the focal point of many of the detailed operations planning and execution activities, including:*

- *Resource Allocation: The POIC supports the IWG in managing the allocation of resources to the current payload complement according to the rules and guidelines established in the Tactical Operations Plan and Flight Increment Plan. It supports real-time replanning through reallocation of resources based on space system and crew status updates provided by the SSSC.*
- *User Gateway to Onboard Operations: The POIC collects user requirements for voice and data link to and from the manned base. It then works with the SSSC to enable implementation of these requirements consistent with Program groundrules for crew safety, data systems utilization, and onboard systems configuration management and control.*
- *Support User Planning Activities: The POIC supports user increment execute planning and real-time replanning activities, directly or through their respective DOCs, ROCs, or UOFs. The POIC also serves as the users agent to the SSSC.*
- *Conflict Resolution: The POIC provides a dispute resolution function between users, with final resolution authority belonging to the IWG consistent with safety standards monitored by the SSSC.*

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[43] *Further details on the operations of the SSSC and POIC can be found in the Space Operations Panel report.*

[44] *Crew training procedures are discussed in Section IV D.*

[45] *Station and STS astronauts will be able to share many basic training facilities and functions, but many of the skills will differ and will require specialized training. For instance, Station crew will not require many of the specialized pilot skills necessary for STS astronauts.*

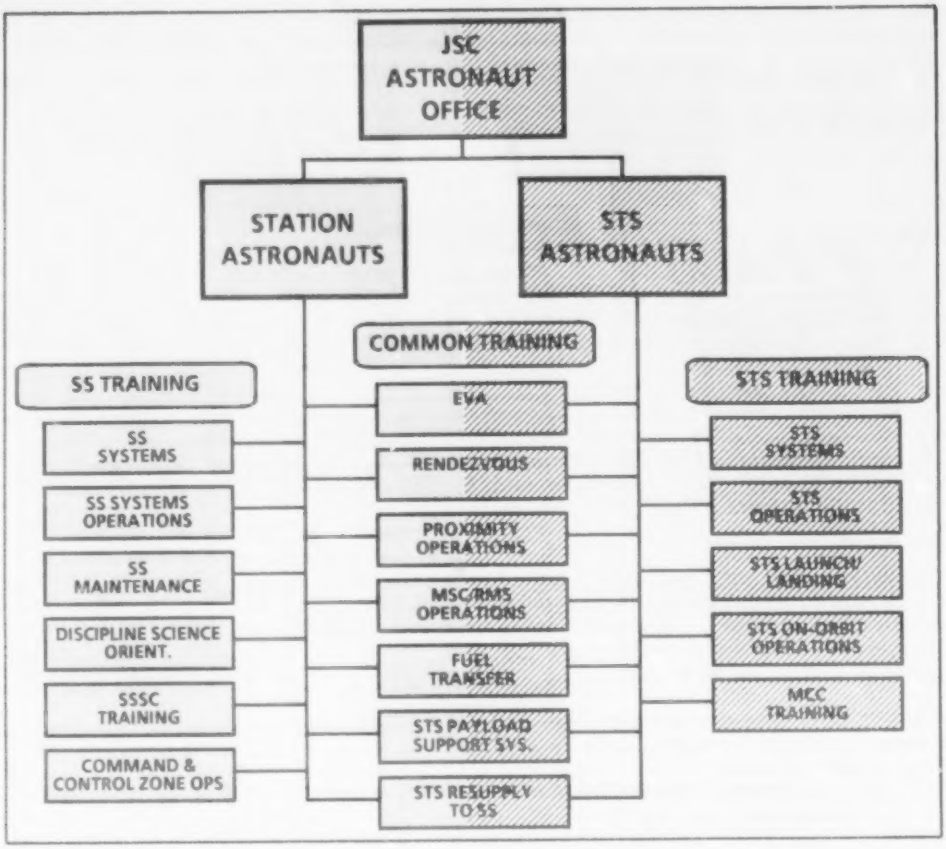
JSC ASTRONAUT OFFICE
STATION ASTRONAUTS
STS ASTRONAUTS
COMMON TRAINING
SS TRAINING
STS TRAINING
SS SYSTEMS
SS SYSTEMS OPERATIONS
SS MAINTENANCE
DISCIPLINE SCIENCE ORIENT.
SSSC TRAINING
COMMAND & CONTROL ZONE OPS
EVA
RENDEZVOUS
PROXIMITY OPERATIONS
MSC/RMS OPERATIONS
FUEL TRANSFER
STS PAYLOAD SUPPORT SYS.
STS RESUPPLY TO SS
STS SYSTEMS
STS OPERATIONS
STS LAUNCH/ LANDING
STS ON-ORBIT OPERATIONS
MCC TRAINING

Figure III-16 SS/STS Astronaut Organization Training Commonality

The Task Force Framework establishes three astronaut classifications: Station Operator (SO), Station Scientist (SS) and Payload Scientist (PS). The SO and SS categories will be career astronauts, supplied by all the partners. Station Operators are dual-function crew members whose primary emphasis is on IVA system operations, EVA, control and maintenance; secondary functions would include science and technology support for user payload operations. Station Scientists will have similar skills, but their focus would be reversed: the majority of their activity will be devoted to IVA and EVA user operations support.[46] Payload Scientists will be non-career crew members with skills in science, engineering or technology development user disciplines. They will be flown in conjunction with unique payloads (e.g., proprietary commercial R&D projects) which justify a non-career payload-specialized astronaut. It is important to recognize, however, that the extended duration of flight increments implies that Payload Scientists will have to support a variety of user payloads in addition to the primary payload(s) which justify their presence.[47] Hence, Payload Scientists must be incorporated into the crew at the start of the increment training cycle and be capable of supporting multiple payloads within their discipline.

Station operations are typified by "splitting" the eight crew members into two four-man teams working in twelve-hour shifts (nine hours scheduled, three hours on call).[48] A full crew complement would typically include one "special operations" team (including EVA-trained astronauts) and one general purpose operations team. Special operations teams would be more heavily "weighted" towards career astronauts, because of the emphasis on EVA activities, while general purpose operations teams would offer more opportunity for non-career Payload Scientists.

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[46] *EVA activities will include repair and maintenance of external components, logistics resupply, and servicing and repair of external payloads, the co-orbiting platform and other spacecraft. Due to the added risk and increased operational requirements in performing EVA (two astronauts are required for "buddy system" safety, plus one astronaut inside to provide support), EVAs will be minimized as much as possible.*

[47] *EVA activities will normally be performed by Station Scientists, even for user payloads. It was the judgement of the Task Force that the cost and complexity of training a Payload Scientist to perform EVA would rarely be warranted.*

[48] *Based on a 90-day stay time, each four-man team would remain on orbit for two full increments.*

In addition to these "activity titles", one member of each shift will be designated as the Station Commander and will be responsible for manned base safety and crew coordination. Since each four-man team has a commander assigned during the training phase, one must be chosen to lead on-orbit activities for a specific increment. Selection will be performed by the Program on a case-by-case basis. A number of "rules-of-thumb" could be used. For example, the astronaut with the most manned base flight experience could be designated Station Commander. Alternatively, the Station Commander for a given flight increment could be the one who is completing his second increment. The Station Commander will be a NASA career astronaut with previous experience; and could be either a Station Operator or a Station Scientist.

Users will have an opportunity to influence the selection and assignment of crews. The SSOTF recommends the creation of a user panel chartered by the Program to help define astronaut skill requirements for future user support and to critique current astronaut performance of user operations support activities. This panel will recommend scientists, engineers and technologists for selection as Station Scientists and Payload Scientists, and will periodically review the Program's flight crew policies and practices as they affect the quality of payload operations.

Crews will be assigned, trained and flown as unified teams to enhance safety and promote efficient operations onboard the manned base. Career astronaut candidates will be selected by the astronaut organization, with suggestions from Station- chartered user panels. The JSC Astronaut Office will make the final astronaut selection recommendations and forward them to the head of the utilization and operations organization. Increment assignments will be made by the JSC Astronaut Office. Payload Scientists will be nominated by the user community. Their nomination procedures shall be user-defined, but must conform with minimum Program astronaut qualification standards. Final approval of PS candidates will be made by the head of the utilization and operations organization, based on the recommendation of the JSC Astronaut Office. International participation in this process is expected, and will be specified by MOUs.

The JSC astronaut organization will define the skill requirements (e.g., minimum levels of training, physical condition, etc.) needed by all career Station astronauts. It is assumed that "basic training" for all new astronauts will take approximately 30-36 months, equivalent to the current profile for STS astronaut training. Assigned crews will train as a team for approximately eighteen months prior to launch for specific payload and systems tasks assigned to their flight increments. Between missions, it is assumed that Station scientists will work closely with the users in payload and experiment definition and procedures, while Station operators will spend a significant amount of their time assisting with the Station's sustaining engineering and operations functions.

- **Engineering Support Operations**

NASA and its partners must provide an ongoing engineering support capability to the Program for sustaining the performance of baselined space systems. This support will be provided through distributed Engineering Support Centers (ESCs) located at each NASA and partner element development and launch center. ESCs will provide personnel and technical analysis capabilities to support routine space systems sustaining engineering activities as well as "on call" support to the Station execute teams for analysis of unanticipated situations onboard Station elements.

Space Systems sustaining engineering can be divided into three major categories: systems maintenance engineering (engineering required to keep baselined space systems operating at peak performance); systems design engineering (engineering analyses performed in support of design modifications); and payload integration engineering (engineering in support of user payload operations and integration).

-- Space Systems Maintenance Engineering: This category includes the engineering support required to keep space systems operational. This consists of planning and execution support provided by the launch site and development center ESCs on space systems ORU hardware, and ESC analyses of assigned flight hardware, including: engineering analyses, safety analyses, anomaly tracking and disposition, maintenance procedures development and verification, modification, repair, installation, testing and flight certification. It also includes the management, control, ground personnel training and scheduling required to perform these activities, as well as technical coordination with contractors and Program interfaces (e.g., development activities).

-- Space Systems Design Modifications Engineering: This activity will be performed by the development center ESCs (routinely or upon request) on their assigned space systems hardware and software, including: performance and trends analyses, safety analyses, anomaly tracking and flight hardware systems disposition, design engineering, procedures development and verification, modification, repair, installation, testing and flight certification. This also includes the management, control, ground personnel training and scheduling required to perform these activities, as well as technical coordination with other ESCs, contractors, and Program interfaces.

-- Payload Integration Engineering: This category supports user payload operations and integration at the launch site or development center ESCs (routinely or upon request) on Program-approved payloads, including: space systems compatibility analyses, safety analyses, payload-to-element integration, payload-to-Station integration, and development of test and checkout procedures. It also includes launch site installation, testing and flight certification. Additionally, it includes the management, control, ground personnel training and scheduling required to perform these activities, as well as technical coordination with users, other ESCs, contractors, and Program interfaces.

As the operations of the various space and ground support systems becomes routine and their operating characteristics become more predictable and stable, the SSOTF suggested centralizing the sustaining engineering function for space systems at the launch site(s).[49] This entails transitioning the sustaining engineering expertise in a gradual manner from the distributed development centers and their geographically dispersed contractors to a corresponding set of expertise at the launch site(s).

Focusing space systems sustaining engineering at the launch site(s) takes advantage of the "hands-on" hardware engineering expertise developed by the launch processing teams; provides central locations for integration, test, and verification of system and payload interfaces; and centralizes and simplifies the development of on-orbit maintenance procedures. The transition will also gradually relieve the development centers of their responsibility for the more routine aspects of Program operations and permit them to transition engineering skills back into design and development activities.

Many of the facilities necessary to support this suggestion will be in place at the launch sites (e.g., test and integration facilities and logistics operations facilities). However, there will be some additional costs involved in relocating specific system and subsystem testbeds and prototypes from the development centers to the launch site(s). There may also be requirements to develop training capabilities and facilities at the launch site(s) to train crews for on-orbit sustaining engineering or repair tasks.

The suggestion must also take into consideration the fact that the development centers (both NASA's and its Partners') will have built up approximately ten years of "organizational inertia" during the development, assembly, and early operations phases of the Program. This will lead to some risk not only in transitioning responsibility away from the development centers, but also in acquiring and retaining the correct engineering skill mix at the launch site(s). While the idea of eventually centralizing the responsibility for space systems sustaining engineering at the launch sites appears to have merit, the SSOTF encourages more detailed studies to determine the feasibility, benefits and costs associated with this suggestion.

## Summary

Figure III-17 summarizes the explanation of the manned base Recommended Framework and indicates a number of key features. Strategic utilization planning is performed at the national level, with user resources allocated to the partners via MOU provisions. Users will steer the utilization planning at this level for the U.S. via their inputs from the SSUB. The Station operations organization will integrate the national utilization plans with Station systems maintenance requirements to form the five-year CUP, two-year TOP and various FIPs. Users will participate at all management levels of the Program. However, the Station Program will retain control over and perform the functions associated with overall manned base space operations. The international partners will be integrated at all management levels of the Program.

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[49] *Responsibility for sustaining engineering of the ground support systems would remain distributed to respective NASA and Partner operations centers.*

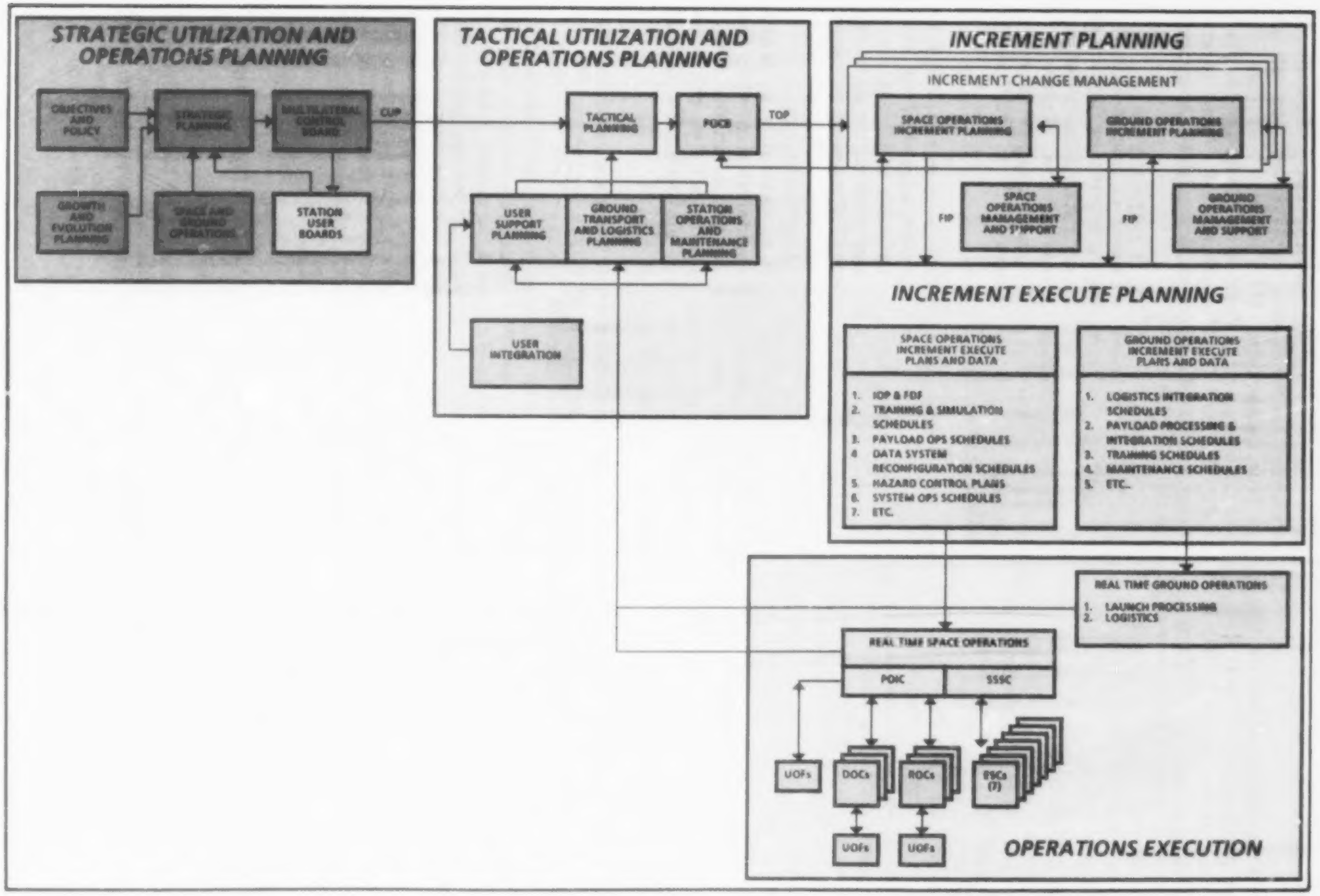

STRATEGIC UTILIZATION AND OPERATIONS PLANNING
OBJECTIVES AND POLICY
STRATEGIC PLANNING
MULTILATERAL CONTROL BOARD
CUP
GROWTH AND EVOLUTION PLANNING
SPACE AND GROUND OPERATIONS
STATION USER BOARDS
TACTICAL UTILIZATION AND OPERATIONS PLANNING
TACTICAL PLANNING
POCB
TOP
USER SUPPORT PLANNING
GROUND TRANSPORT AND LOGISTICS PLANNING
STATION OPERATIONS AND MAINTENANCE PLANNING
USER INTEGRATION
INCREMENT PLANNING
INCREMENT CHANGE MANAGEMENT
SPACE OPERATIONS INCREMENT PLANNING
GROUND OPERATIONS INCREMENT PLANNING
FIP
SPACE OPERATIONS MANAGEMENT AND SUPPORT
FIP
GROUND OPERATIONS MANAGEMENT AND SUPPORT
INCREMENT EXECUTE PLANNING
SPACE OPERATIONS INCREMENT EXECUTE PLANS AND DATA
1. IOP & FDF
2. TRAINING & SIMULATION SCHEDULES
3. PAYLOAD OPS SCHEDULES
4 DATA SYSTEM RECONFIGURATION SCHEDULES
5. HAZARD CONTROL PLANS
6. SYSTEM OPS SCHEDULES
7. ETC.
GROUND OPERATIONS INCREMENT EXECUTE PLANS AND DATA
1. LOGISTICS INTEGRATION SCHEDULES
2. PAYLOAD PROCESSING & INTEGRATION SCHEDULES
3. TRAINING SCHEDULES
4. MAINTENANCE SCHEDULES
5. ETC.
REAL TIME GROUND OPERATIONS
1. LAUNCH PROCESSING
2. LOGISTICS
REAL TIME SPACE OPERATIONS
POIC
SSSC
UOFs
DOCs
ROCs
ESCs (7)
UOFs
UOFs
OPERATIONS EXECUTION

Figure III-17 Summary: Manned Base Operations Framework

### III.B.3. Platform Operations Framework

The Platform Operations Framework addresses the U.S. co-orbiting and polar platforms (COP and POP respectively). The European Space Agency (ESA) is also providing a polar orbiting platform. Although ESA platform requirements will be included in overall program planning, it will operate independently of the U.S. platforms. Hence, operation of the ESA platforms is not addressed by this Framework.

The Task Force developed a separate Framework for platform operations. The primary reason for doing so is that except for servicing of the co-orbiting platform at the manned base, the COP and POP have considerably different operational characteristics and functional requirements. Platform systems operations are controlled exclusively from the ground whereas the manned base will be controlled by the ground and by the onboard crew. The unmanned platforms will carry a smaller complement of payloads than the manned base (perhaps only one "facility class" instrument). They will also operate for several months or even years without requiring servicing, payload changeout, or manned interaction. With the exception of enhanced opportunities for servicing of the co-orbiting platform, planning and conducting platform operations in the Space Station era will not be significantly different from present-day unmanned satellite operations.

Although largely independent from manned base operations, the platforms will share common support services such as engineering support, transportation and logistics services, and tracking and data relay services. Commonality will also be provided at the systems/ORU-level for the spacecraft (e.g., basic power systems, communications and tracking, user interfaces, and the basic data management system).

The recommended Platform Operations Framework reflects the unique operational requirements of these unmanned spacecraft. Figure III-18 illustrates the most likely early utilization of the platforms: an earth observing mission for the POP and an astrophysics mission for the COP. These representative configurations reflect a significant difference between the platforms and the manned base; each platform will essentially be a unique spacecraft reflecting the Mission Sponsor's payload requirements. (I.e., most platforms are likely to be "mission-unique," although there are provisions for "multi-mission" platforms supporting different science disciplines).

The Space Station Program's unmanned platforms will support a variety of science and technology users. They may also support operational missions such as weather observation and land and ocean resources mapping. The co-orbiting platforms may also be used to support commercial space research or commercial processing and manufacturing. Figure III-19 illustrates the Platform Operations Infrastructure supporting not only the on-orbit phases, but the planning, scheduling, prelaunch, and ground support activities necessary to conduct the mission of the platform and its payloads.

The SSOTF investigated a number of alternatives for Platform Mission Management. These alternatives divide the overall functional responsibilities for managing a particular platform mission between the Space Station Program and the user. Functional responsibilities for mission management support fall into four categories: (1) Platform Supplier; (2) Platform operator; (3) Payload operator; and (4) other Mission Support (i.e. launch support, institutional support, payload development, and payload integration with the platform).

The Platform Mission Manager is responsible for coordinating and managing each of these functional areas to provide the services and capabilities necessary to achieve the mission success criteria. Table III-7 provides a summary of the various mission alternatives developed by the SSOTF to characterize platform operations.

The SSOTF observed that short term missions appear to be more applicable to Alternatives 1 and 2; long term missions appear to be more applicable to Alternatives 4 and 5. "Quick is Beautiful" user missions for platforms appear to be more applicable to COP missions managed under Alternative 1.

For short term missions it is desirable to leave sustaining engineering responsibilities with the Platform operator. For longer term missions, sustaining engineering responsibilities could be transferred to the user but maintenance of this capability will be difficult.

The SSOTF concluded that: (1) the program should not preclude the selection of any alternative; (2) the selection of the Mission Management alternative should be made on a mission-by-mission basis; and (3) the first COP and POP platform mission should initially be managed under Alternative 1 to ensure accomplishment of Program engineering, utilization and operations objectives. After successfully demonstrating the platforms' capabilities, alternatives 4 and 5 may be implemented on future platforms. The Station Program should also retain responsibility for planning and conducting any Transfer operations for early platforms and payloads.

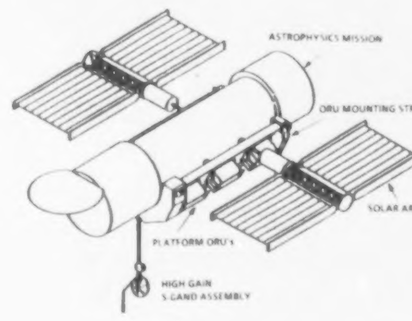
#### III.B.3.a. Strategic Utilization and Operations Planning

Figures III-20 and 21 summarize the end-to-end planning process for the U.S. polar and co-orbiting platforms. The major difference between the POP and COP processes is that the COP transfer (servicing) operations planning is fully integrated into the manned base planning flow. Similar to the manned base, these two planning processes serve as the focal point for describing the Platform Operations Framework.

Program Policy level planning is common with manned base strategic planning in order to provide overall Program planning coordination (provided through the CUP). Platforms will be managed by the contributing partner at the Program Integration and Program Execution levels. (The U.S. and ESA platforms will be managed independently.) Platform tactical planning and operations execution are also independent of the manned base except for COP transfer operations requiring manned base servicing activity.

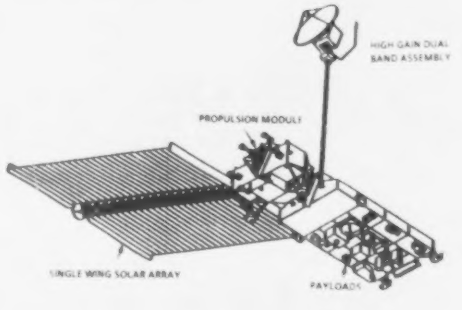
| | PLATFORM SUPPLIER | MISSION MANAGER | PLATFORM OPERATOR | PAYLOAD OPERATOR |
|---|---|---|---|---|
| ALTERNATIVE 1 | SPACE STATION PROGRAM | SPACE STATION PROGRAM | SPACE STATION PROGRAM | USER |
| ALTERNATIVE 2 | SPACE STATION PROGRAM | USER | SPACE STATION PROGRAM | USER |
| ALTERNATIVE 3 | SPACE STATION PROGRAM | SPACE STATION PROGRAM | USER | USER |
| ALTERNATIVE 4 | SPACE STATION PROGRAM | USER | USER | USER |
| ALTERNATIVE 5 | USER | USER | USER | USER |

Table III-7 Platform Mission Management Alternatives


ASTROPHYSICS MISSION
ORU MOUNTING STRUCTURE
SOLAR ARRAY
PLATFORM ORU's
HIGH GAIN
S-BAND ASSEMBLY

- ASTROPHYSICS TELESCOPE CONFIGURATION
- ORBIT ALTITUDE: 463 TO 1000 Km; INCLINATION 28.5°
- LAUNCH SEQUENCE: AUGUST, 1996
- SERVICING AT SHORTER THAN 2 YEAR INTERVALS FOR CRYOGEN REPLENISHMENT
- LONG MISSION LIFE: 10 TO 15 YEARS
- LAUNCH VEHICLE: STS AND OMV
- USER REQUIREMENTS: SIRTF AND AXAF
- PEAK DATA RATE: <.6 Mbps

CO-ORBITING PLATFORM (COP)


HIGH GAIN DUAL
BAND ASSEMBLY
PROPULSION MODULE
SINGLE WING SOLAR ARRAY
PAYLOADS

- EARTH OBSERVING MISSION DRIVEN
- ORBIT ALTITUDE: 500 TO 900 Km (OPERATIONAL)
  - INCLINATION 98° (APPROXIMATELY)
  - SUN SYNCHRONOUS
- DEPLOYMENT ALTITUDE: 240 KM
- SERVICING ALTITUDE: HIGHER THAN 240 KM
- LAUNCH SEQUENCE: NOVEMBER 1993
- LAUNCH VEHICLE: STS AND PLATFORM PROPULSION
  OPTION: ELV AND PLATFORM PROPULSION (INITIAL DEPLOYMENT)
- PEAK DATA RATE: 300 Mbps
- SERVICING: AFTER 1-2 YEARS TO ADD PAYLOAD AND EXCHANGE PROPULSION MODULE IF STS LAUNCHED
- LONG MISSION LIFE: UP TO 30 YEARS WITH SERVICING
- USER REQUIREMENTS: MISSION REQUIREMENTS DATA BASE

POLAR ORBITING PLATFORM (POP)

Figure III-18 Orbiting Platforms

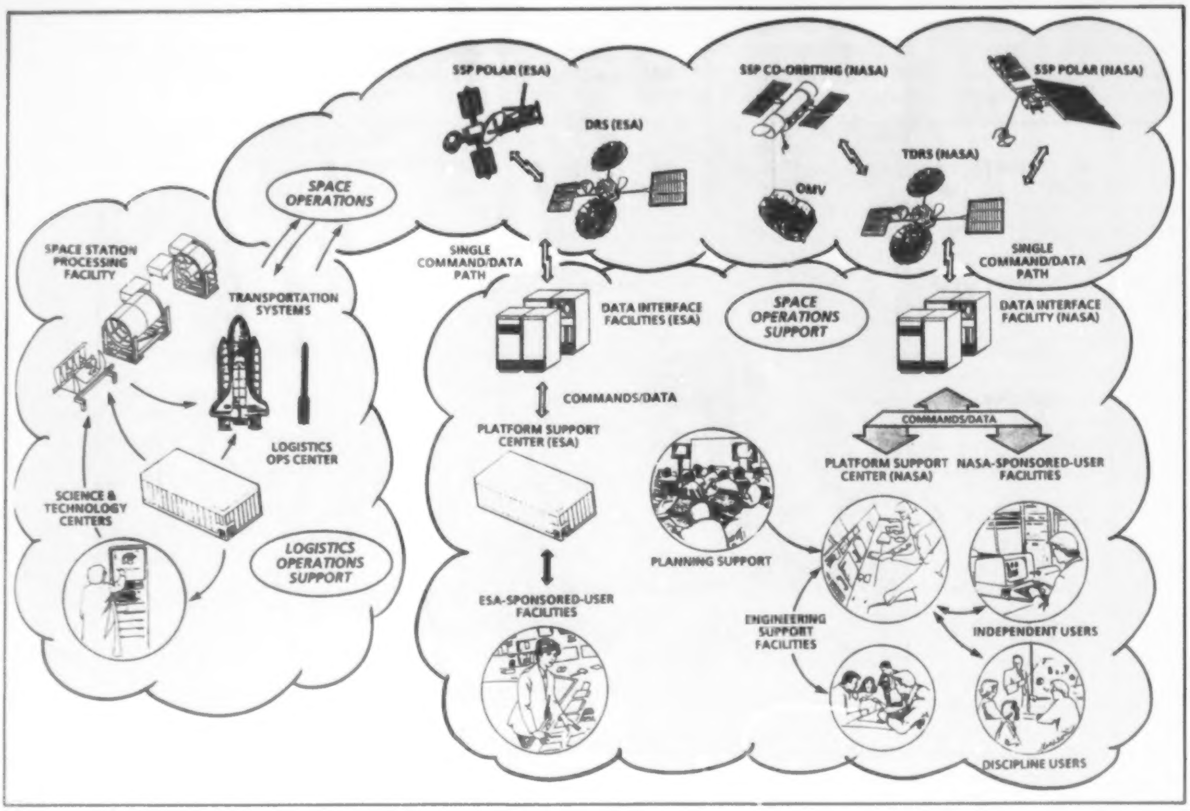

SSP POLAR (ESA)
DRS (ESA)
SSP CO-ORBITING (NASA)
SSP POLAR (NASA)
TDRS (NASA)
OMV
SPACE OPERATIONS
SPACE STATION PROCESSING FACILITY
TRANSPORTATION SYSTEMS
SINGLE COMMAND/DATA PATH
DATA INTERFACE FACILITIES (ESA)
SPACE OPERATIONS SUPPORT
SINGLE COMMAND/DATA PATH
DATA INTERFACE FACILITY (NASA)
COMMANDS/DATA
PLATFORM SUPPORT CENTER (ESA)
COMMANDS/DATA
LOGISTICS OPS CENTER
SCIENCE & TECHNOLOGY CENTERS
PLATFORM SUPPORT CENTER (NASA)
NASA-SPONSORED-USER FACILITIES
LOGISTICS OPERATIONS SUPPORT
PLANNING SUPPORT
ESA-SPONSORED-USER FACILITIES
ENGINEERING SUPPORT FACILITIES
INDEPENDENT USERS
DISCIPLINE USERS

Figure III-19 Platform Operations Infrastructure

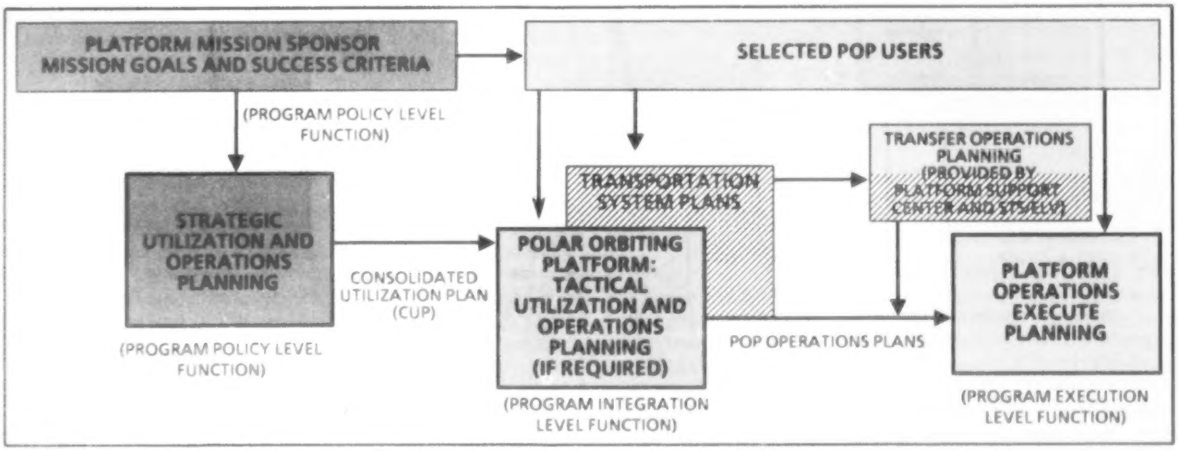

PLATFORM MISSION SPONSOR MISSION GOALS AND SUCCESS CRITERIA
SELECTED POP USERS
(PROGRAM POLICY LEVEL FUNCTION)
TRANSFER OPERATIONS PLANNING (PROVIDED BY PLATFORM SUPPORT CENTER AND STS/ELV)
TRANSPORTATION SYSTEM PLANS
STRATEGIC UTILIZATION AND OPERATIONS PLANNING
CONSOLIDATED UTILIZATION PLAN (CUP)
POLAR ORBITING PLATFORM: TACTICAL UTILIZATION AND OPERATIONS PLANNING (IF REQUIRED)
PLATFORM OPERATIONS EXECUTE PLANNING
POP OPERATIONS PLANS
(PROGRAM POLICY LEVEL FUNCTION)
(PROGRAM INTEGRATION LEVEL FUNCTION)
(PROGRAM EXECUTION LEVEL FUNCTION)

Figure III-20 Platform Operations Framework -- Polar Orbiting Platform

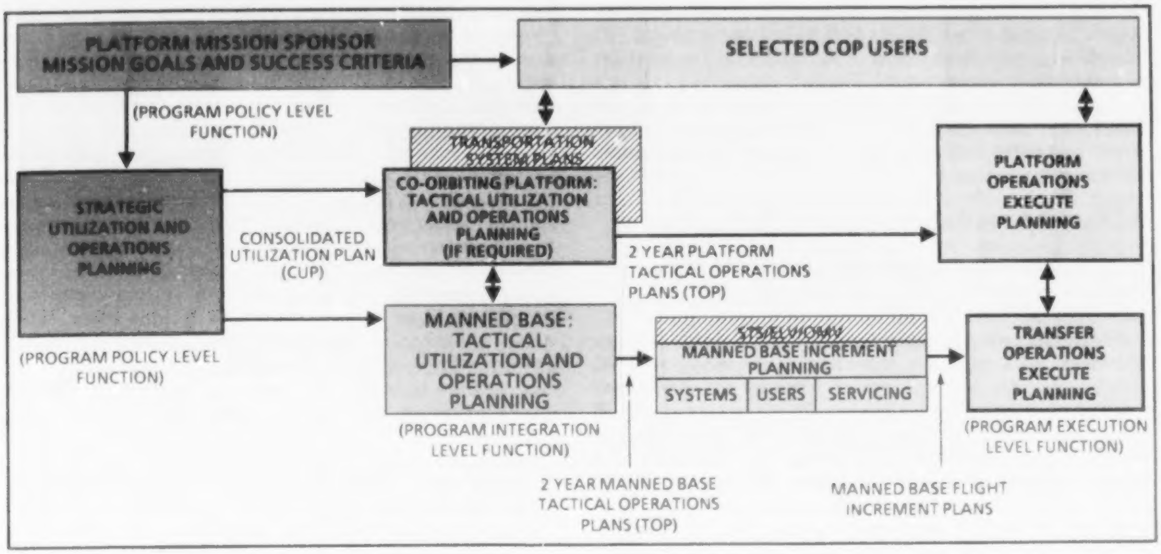

PLATFORM MISSION SPONSOR
MISSION GOALS AND SUCCESS CRITERIA
SELECTED COP USERS
(PROGRAM POLICY LEVEL FUNCTION)
TRANSPORTATION SYSTEM PLANS
CO-ORBITING PLATFORM: TACTICAL UTILIZATION AND OPERATIONS PLANNING (IF REQUIRED)
PLATFORM OPERATIONS EXECUTE PLANNING
STRATEGIC UTILIZATION AND OPERATIONS PLANNING
CONSOLIDATED UTILIZATION PLAN (CUP)
2 YEAR PLATFORM TACTICAL OPERATIONS PLANS (TOP)
MANNED BASE: TACTICAL UTILIZATION AND OPERATIONS PLANNING
STS/ELV/OMV
MANNED BASE INCREMENT PLANNING
SYSTEMS
USERS
SERVICING
TRANSFER OPERATIONS EXECUTE PLANNING
(PROGRAM POLICY LEVEL FUNCTION)
(PROGRAM INTEGRATION LEVEL FUNCTION)
(PROGRAM EXECUTION LEVEL FUNCTION)
2 YEAR MANNED BASE TACTICAL OPERATIONS PLANS (TOP)
MANNED BASE FLIGHT INCREMENT PLANS

**Figure III-21 Platform Operations Framework -- Co-Orbiting Platform**

One of the major strategic decisions made by the Space Station Program's Mission Manager and the user's Mission Sponsor is a definition of the combined platform and payload configuration. As with manned base payloads, the Space Station Program does not define or select the payloads; that is the responsibility of the Mission Sponsor. The Mission Sponsor, with active support from individual users, selects payloads, establishes priorities, and develops requirements for system enhancements of new platforms. The Program reviews proposed mission objectives, approves the use of Program resources, and commits the Program to support.[50]

Key functions performed at the Program Policy level parallel those performed for the manned base and include: (1) mission analyses for the platform, payloads, and required systems support, as well as

***PLATFORM OPERATIONS***

***On-orbit platform operations are characterized by two distinct phases during which the platform will be operated to perform either a series of "missions," or a single mission for the life of the platform and its payload. These phases are Platform Payload operations and Platform Transfer operations.***

***Platform Payload operations: These are the activities performed to meet mission objectives and success criteria. They are comprised of the platform flight and ground systems, the platform's integrated payload(s) flight and ground systems, and supporting systems (e.g., information systems). These day-to-day payload operations focus on providing required support services to onboard payload users.***

***Platform Transfer operations: These activities include: (1) initial launch operations, transfer to operational orbit, and spacecraft test and checkout; (2) on-orbit servicing and maintenance operations for both the platform and its payloads; and (3) recovery or re-entry operations to remove a platform and its payload(s) from orbit.***

***The Platform Support Center (PSC) at the Goddard Space flight Center is responsible for planning and controlling each of these two phases. Other capabilities are provided by the Space Station Program, space transportation systems, and the platform users. The Space Station Information System (SSIS) provides both operational and administrative communications services among all ground locations as well as the space-to- ground services linking the PSC and the users to the platform and its payloads.***

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[50] *While there are a number of alternatives for platform Mission Management, for simplicity in illustrating the Platform Operations Framework, Alternative 1 from Table III-7 is assumed. Hence, the Platform Supplier, Mission Manager, and Platform Operator are assumed to be provided by the Space Station Program. The Mission Sponsor and Payload Operator are provided by the user community.*

definition of support requirements for transportation, logistics, and tracking and data relay systems; (2) platform, payload, and transportation system compatibility assessments; (3) definition of platform systems resource requirements; (4) definition of the final platform configuration; (5) preparation of preliminary implementation and operations plans; and (6) the preparation of preliminary transfer operations plans. The results of these activities serve as inputs to the Consolidated Utilization Plan (CUP).

### III.B.3.b. Tactical Utilization and Operations Planning

It is anticipated that platform increments (time between STS or manned base maintenance and servicing activity) will vary greatly in duration, depending on platform mission objectives and planned orbital lifetime. This results in the need to maintain a flexible approach to the flow of utilization and operations planning documentation at all management levels. Given the temporal scope of the CUP (5 years) and the TOP (2 years) and the fact that platform increments are, in any case, much longer than their manned base counterparts, a platform's planning documentation complement will either consist of a CUP, a TOP, and the various execute plans and data, or simply of a CUP and the supporting execute plans and data. A manned base-type FIP will not be required.[51]

Platform planning activity largely focuses on prelaunch activities. Once on orbit, Program Integration level planning is conducted periodically to update the initial plan. However, these updates are not on a fixed cycle or keyed to a "flight increment" as with manned base operations. Instead, they are highly dependent upon the specific instruments or payloads for which a given platform mission has been defined.[52] In many cases the replanning cycles will be influenced by mission drivers such as seasonal earth observing cycles.

The Mission Management organization serves in the same functional capacity for a single platform as the POCB does for the manned base. The Mission Manager will be supported by an Investigators Working Group (IWG), consisting of representatives from the users and the platform instrument(s) development team. The IWG will formulate recommendations regarding science planning and implementation, and conflict resolution support for user-related planning and operations issues.

The Platform Mission Manager leads the Program Integration level planning process (similar in many ways to the Increment Change Manager's role in supporting the tactical and increment planning processes for the manned base). This process includes developing integrated platform and payload development schedules; scheduling and acquiring re-quired transportation and support services; developing and conducting integrated tests; coordinating payload requirements with the Mission Sponsor and individual investigators; coordinating the formation of an Investigators Working Group (IWG) with the Mission Sponsor and user community; defining data types, flows, processing, and display requirements; establishing and administering Program schedules and budgets; and integrating user and platform system plans and procedures into an Increment Operations Plan (IOP). As in the manned base Framework, the Program will assign a Payload Accommodation Manager (PAM) to assist users through the planning process, as well as the integration, testing and verification of the user's payload.

Once on orbit, platform operations are not subject to frequent changes in configuration and do not have frequent/ routine visits by the STS or servicing from the manned base and their crews. When these changes do occur, they are reflected in a separate Platform Transfer Operations Plan (PTOP). For COP servicing, the Platform Transfer Operations Plans are fully integrated into the manned base planning flow.[53]

### III.B.3.c. Operations Execution

Platform Operations Execution is functionally divided between platform systems support and user operations support. The Program Execution level plans identify the sequence of activities, resource requirements, and timelines required to be executed by both ground and flight systems. User requirements are reflected in three areas: (1) payload scheduling; (2) real-time payload support and instrument operations; and (3) engineering and payload data capture.

Payload scheduling covers the development of specific requirements for instrument operations and payload data collection. Execution plans are generated as required on an orbital, daily, or weekly basis. These plans are then translated into command files which are uplinked to the platform to control and manage the platform and payload configuration.

Real-time payload support and instrument operations include monitoring and coordinating users and platform systems operations (conducted by the PSC). Users operating in telescience mode may command an instrument in real-time in response to observed data. Other real-time (or near real-time) activities could include: fault isolation and restoration and replanning to respond to system/payload anomalies; or implementing a change in instrument operations generated by the user in response to "quick-look" data analysis.

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[51] *In the case where a platform is to be maintained and serviced by the STS or manned base at intervals greater than two years (i.e., an increment duration beyond the scope of the TOP), the CUP data is used directly to generate execute plans and data; in the event the servicing interval is less than two years, a TOP will be required as an interim step to define multi-increment servicing and maintenance requirements.*

[52] *The difference in operations of a POP accommodating earth observation missions, and the operation of a COP accommodating an astrophysics mission (such as a large telescope) precludes a generic definition of Program Integration or Program Execution level planning "increments."*

[53] *The SSOTF concluded that the feasibility of POP servicing requires more study due to concerns over transportation availability, EVA risk, platform complexity and cost to execute the de-orbit and return to operational orbit transfer maneuvers required by STS servicing. If deemed feasible, POP Transfer Operations Plans would be coordinated and developed with the STS Program.*

U.S. platform payload and platform transfer operations will be managed and controlled by a Platform Support Center (PSC).[54] The PSC functions for platform systems control and user support are analogous to the SSSC and POIC functions in the manned base. Support to users for payload operations will be coordinated in the PSC by the Platform Payload Operations Center (PPOC). Actual payload operations will be performed by individual users in user facilities. Platform transfer operations will be planned and conducted in the PSC by the Platform Transfer Operations Center (PTOC). The PTOC will support specialized servicing planning requirements and interface with the manned base and STS increment planning activity. Transfer operations will be managed by the STS operations organization when the STS or STS-based OMV is the servicing vehicle, and by the SSSC when these operations are performed by the Station-based OMV, or when the COP is brought within the 20 nm command and control zone for servicing at the manned base.[55]

The final products of user execution operations are the reports and analyses resulting from the capture and processing of the downlinked instrument data. Platform systems data are also downlinked, captured, and processed by the PSC to provide systems trend analyses, support anomaly investigations, and support the development of maintenance procedures. Systems data may also be required by the users to support their analysis of instrument data. A detailed planning flow reflecting these activities for Platform Operations Execution is illustrated in Figure III-22.[56]

As with the manned base, platform operations will be supported by the Program's Engineering Support Centers (ESC), Logistics Operations Center, Space Station Processing Facility, and the space transportation systems. The Space Station Information System supports user telescience requirements by providing direct access to platform payloads. The SSIS also provides the required communications connectivity among all of the other locations illustrated in Figure III-19.

Figure III-23 provides a summary flow of the platform operations framework from strategic planning through operations execution for normal platform payload operations. Figure III-24 augments this overview by adding the activities required to conduct transfer operations as well as indicating the requisite interfaces with the manned base operations structure. These figures summarize the explanation of the platform operations framework developed by the SSOTF, and indicate a number of key features.

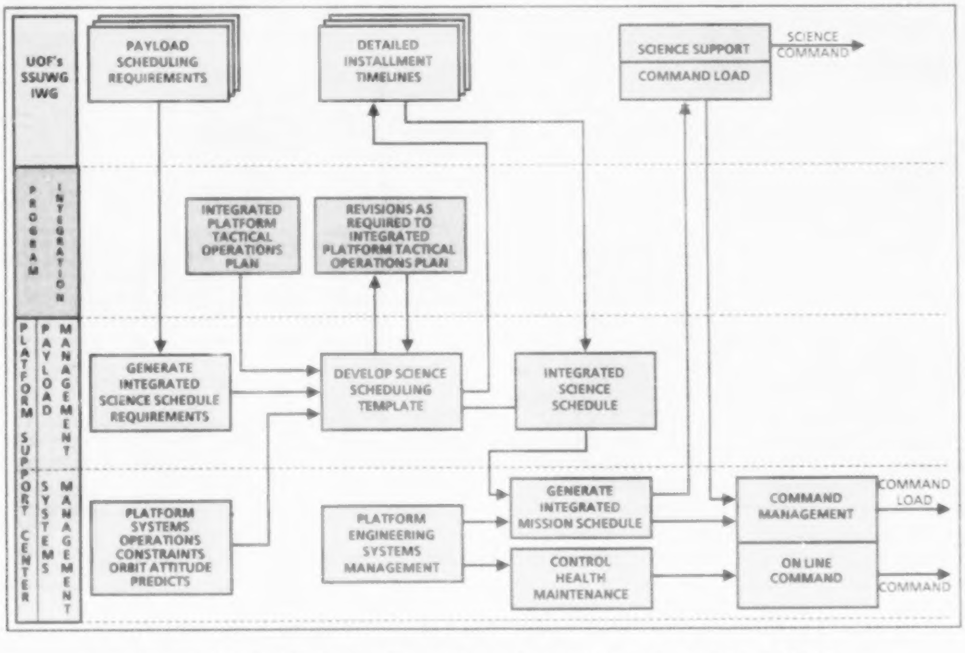
UOF's
SSUWG
IWG
PROGRAM INTEGRATION
PLATFORM SUPPORT CENTER
PAYLOAD MANAGEMENT
SYSTEMS MANAGEMENT
PAYLOAD SCHEDULING REQUIREMENTS
DETAILED INSTALLMENT TIMELINES
SCIENCE SUPPORT
COMMAND LOAD
SCIENCE COMMAND
INTEGRATED PLATFORM TACTICAL OPERATIONS PLAN
REVISIONS AS REQUIRED TO INTEGRATED PLATFORM TACTICAL OPERATIONS PLAN
GENERATE INTEGRATED SCIENCE SCHEDULE REQUIREMENTS
DEVELOP SCIENCE SCHEDULING TEMPLATE
INTEGRATED SCIENCE SCHEDULE
PLATFORM SYSTEMS OPERATIONS CONSTRAINTS ORBIT ATTITUDE PREDICTS
PLATFORM ENGINEERING SYSTEMS MANAGEMENT
GENERATE INTEGRATED MISSION SCHEDULE
CONTROL HEALTH MAINTENANCE
COMMAND MANAGEMENT
ON LINE COMMAND
COMMAND LOAD
COMMAND

Figure III-22 Platform Operations Execution -- Functional Flow

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[54] *The ESA platform(s) will be controlled by a separate ESA control center.*

[55] *The COP will normally be maneuvered into the same orbital inclination as the manned base, permitting servicing by any of these methods. The POP will only be serviced by the STS, possibly in conjunction with an OMV, at the operational altitude of the Shuttle in polar orbit. The Program baseline assumes STS launch and use of STS or manned base with OMV for servicing.*

[56] *A parallel discussion and illustration for Transfer Operations is contained in the Space Operations Panel report.*

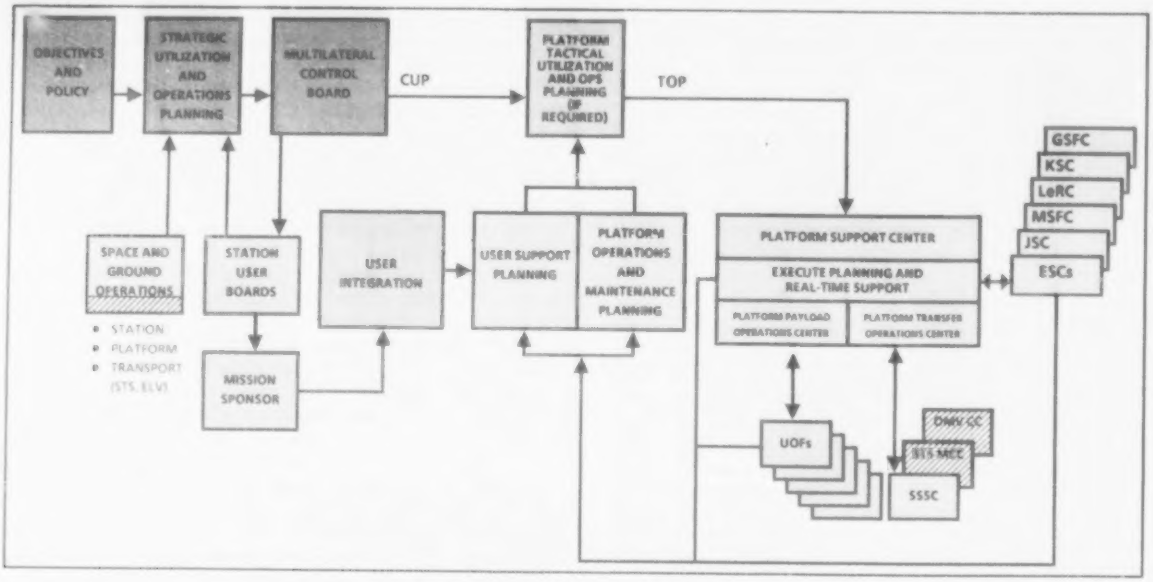
OBJECTIVES AND POLICY
STRATEGIC UTILIZATION AND OPERATIONS PLANNING
MULTILATERAL CONTROL BOARD
CUP
PLATFORM TACTICAL UTILIZATION AND OPS PLANNING (IF REQUIRED)
TOP
GSFC
KSC
LeRC
MSFC
JSC
ESCs
SPACE AND GROUND OPERATIONS
• STATION
• PLATFORM
• TRANSPORT (STS, ELV)
STATION USER BOARDS
MISSION SPONSOR
USER INTEGRATION
USER SUPPORT PLANNING
PLATFORM OPERATIONS AND MAINTENANCE PLANNING
PLATFORM SUPPORT CENTER
EXECUTE PLANNING AND REAL-TIME SUPPORT
PLATFORM PAYLOAD OPERATIONS CENTER
PLATFORM TRANSFER OPERATIONS CENTER
UOFs
OMV CC
STS MCC
SSSC

Figure III-23 Co-Orbiting And Polar Platforms Payload Operations Framework Overview

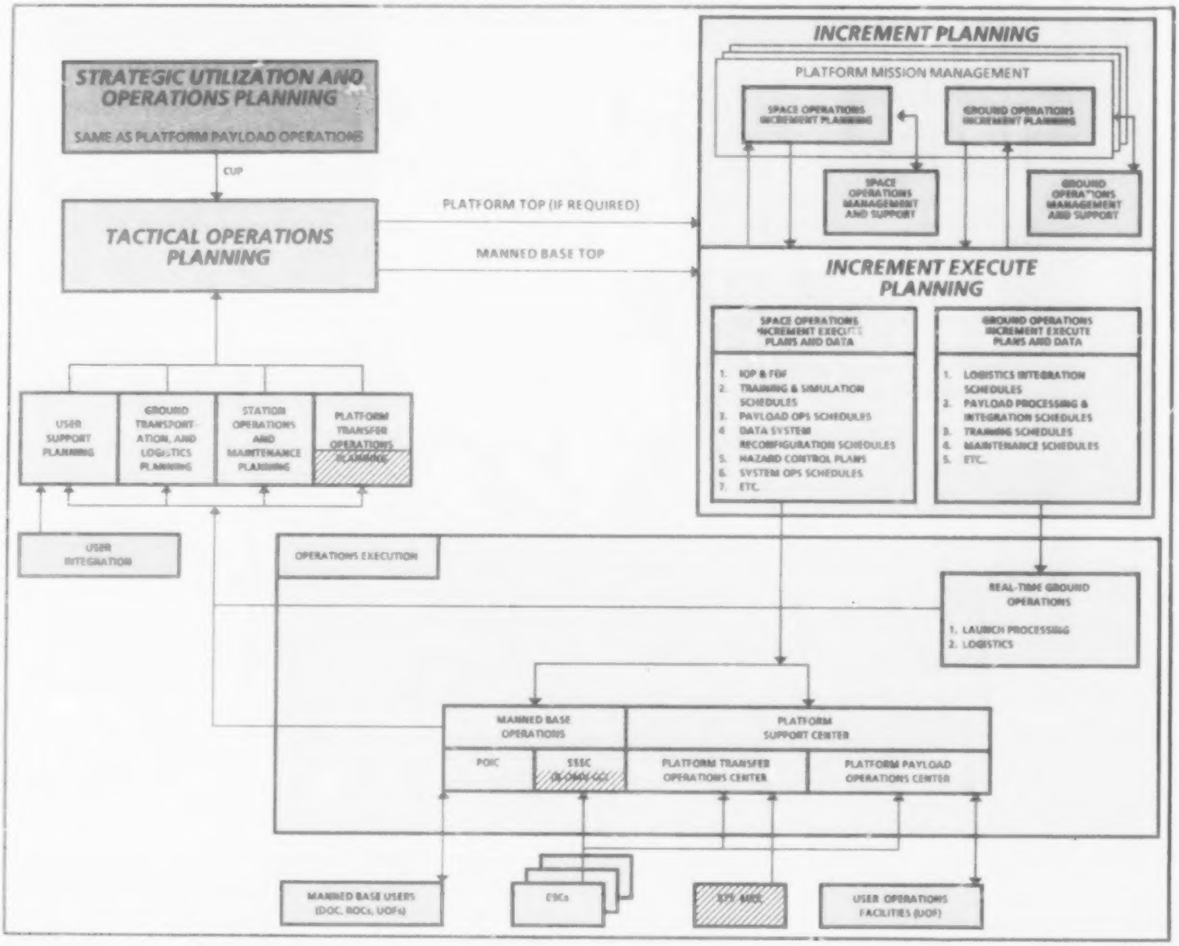
STRATEGIC UTILIZATION AND OPERATIONS PLANNING
SAME AS PLATFORM PAYLOAD OPERATIONS
CUP
TACTICAL OPERATIONS PLANNING
PLATFORM TOP (IF REQUIRED)
MANNED BASE TOP
INCREMENT PLANNING
PLATFORM MISSION MANAGEMENT
SPACE OPERATIONS INCREMENT PLANNING
GROUND OPERATIONS INCREMENT PLANNING
SPACE OPERATIONS MANAGEMENT AND SUPPORT
GROUND OPERATIONS MANAGEMENT AND SUPPORT
INCREMENT EXECUTE PLANNING
SPACE OPERATIONS INCREMENT EXECUTE PLANS AND DATA
1. IOP & FOF
2. TRAINING & SIMULATION SCHEDULES
3. PAYLOAD OPS SCHEDULES
4 DATA SYSTEM RECONFIGURATION SCHEDULES
5. HAZARD CONTROL PLANS
6. SYSTEM OPS SCHEDULES
7. ETC.
GROUND OPERATIONS INCREMENT EXECUTE PLANS AND DATA
1. LOGISTICS INTEGRATION SCHEDULES
2. PAYLOAD PROCESSING & INTEGRATION SCHEDULES
3. TRAINING SCHEDULES
4. MAINTENANCE SCHEDULES
5. ETC.
USER SUPPORT PLANNING
GROUND TRANSPORTATION, AND LOGISTICS PLANNING
STATION OPERATIONS AND MAINTENANCE PLANNING
PLATFORM TRANSFER OPERATIONS PLANNING
USER INTEGRATION
OPERATIONS EXECUTION
REAL-TIME GROUND OPERATIONS
1. LAUNCH PROCESSING
2. LOGISTICS
MANNED BASE OPERATIONS
PLATFORM SUPPORT CENTER
POIC
SSSC
PLATFORM TRANSFER OPERATIONS CENTER
PLATFORM PAYLOAD OPERATIONS CENTER
MANNED BASE USERS (DOC, ROCs, UOFs)
ESCs
STS MCC
USER OPERATIONS FACILITIES (UOF)

Figure III-24 Platform Transfer Operations Framework Overview

*SUMMARY FEATURES: PLATFORM OPERATIONS FRAMEWORK*

- *Platform Program Policy level planning is common with manned base strategic planning to provide overall Program planning continuity. Program Integration level planning varies in scope according to platform increment duration. Program Execution level planning and mission execution coordination is performed by the PSC.*
- *Each platform is separately managed by the Program contributor at the Program Execution level; the U.S. manages its COP and POP, ESA manages the ESA polar platform.*
- *Program Integration and Program Execution level operations are independent of manned base operations except for COP Transfer operations (manned base servicing of the Co-orbital Platform).*
- *The Framework assumes commonality in systems hardware down to the ORU-level to support cost savings in design, development and operations.*
- *U.S. platform operations are managed at a centralized Platform Support Center located at GSFC with the following features: (1) operations are modeled after past platform experience; (2) remote user operations (telescience) will be a standard mode of operation; and (3) sustaining engineering support is shared with the manned base for common systems.*

## III.C. ORGANIZING FOR OPERATIONS

### III.C.1. Organizational Philosophy

As specified in its charter, the SSOTF analyzed alternative Space Station operations organizations to implement the Recommended Framework for the Mature Operations Phase of the Program. These alternatives were then examined for their applicability to both the Development and Evolutionary Phases of the Program.

Based on this analysis, the Task Force recommended that the Program should create immediately a Space Station Operations Organization separate from the Space Station Development Organization. This separation should continue throughout the assembly, verification, mature operations and evolutionary Program phases. The Task Force based this recommendation on the following principal characteristics of the Station operations environment:

(1) The NASA administrator has recently directed key Agency personnel and several study groups to analyze and make specific recommendations to better focus multi-program spaceflight operations across the Agency from an organizational perspective. The above SSOTF recommendation is consistent with this effort.

(2) The Space Station operational "system" will be quite large, encompassing multiple NASA centers, several international partners, and numerous technically and functionally complex disciplines. Many of these groups have not been integrally involved in the "operations" aspects of previous manned space programs (e.g., Program marketing and logistics support). The situation will be further complicated as the Mature Operations Organization takes on user integration and sustaining engineering responsibilities, while the Development Organization moves on to develop Station evolutionary systems and support other NASA initiatives.

Thus, the management effort required to develop and implement an initial operations capability for this system will be as great as that required to develop and verify the spacecraft systems. The establishment of a separate Operations Organization in the near term will allow both the Development and Operations Organizations to develop the necessary systems, procedures and expertise by the time of initial element launch, and will allow the Operations Organization to mature along with the technical capabilities of the Program.

(3) The SSOTF anticipated that the U.S. Executive and Legislative Branches would continue to be concerned with the prediction, management and control of annual Space Station operations costs throughout the life of the Program. An organizational structure which clearly differentiates operations support functions from those associated with systems development would facilitate operations cost management and control. It would support the projection of ongoing operations performance and costs by primary function, measurement of operational resources expended over each operations increment, and collection of overall operations resource utilization data. This approach would also minimize any budgetary conflict of interest between the development of flight systems hardware and software and the development of ground-based operations support systems.

Additionally, the Office of Space Station should begin immediately to establish Program interface agreements with each NASA institution which will support Station operations. This includes interfaces between the Station Program and each affected Associate Administrator and Center Director. These agreements will serve to broadly define the various Center commitments which will subsequently become a part of their Program Operating Plan submittals during the Development and subsequent Mature Operations Phases of the Program. Typically, these agreements should cover the significant institutional manpower requirements and requirements for development or enhancement of critical support centers, facilities, and systems. They must also cover the major commitments by the NASA transportation systems providers as well as the providers of communication and data systems services.

### Evaluation Criteria

The SSOTF recognized that any operational organization which it recommends must conform to NASA policy concerning Headquarters-centralized management control as well as with overall Program goals. Specifically, these criteria included:

(1) The organization must be hierarchically and functionally structured to centralize Program management and control at NASA Headquarters, with Program implementation support distributed as appropriate to participating NASA centers.

(2) The organization must provide clearly defined user interfaces to the Program at each hierarchical level, and must integrate user requirements so as to minimize the number of these interfaces.

(3) The organization must provide for effective and politically acceptable international participation at each hierarchical level and within each level's organizational elements, while preserving NASA's role as overall Program leader.

(4) The organization must clearly define the Program support functions assigned to each participating NASA center while leaving each center flexibility regarding specific implementation approaches (e.g., project vs. matrix organization).

(5) The organization must be able to adapt to accommodate the varying requirements of the Program's phases.

After considering these criteria and other anticipated characteristics of the Program operations environment, the SSOTF recommended a Mature Operations Phase organizational structure as illustrated by Figure III-25. It should be noted that although the SSOTF assumed that this organization would be directed by an Associate Administrator (AA) for Space Station Operations, the hierarchical distribution of functions would remain generally valid if incorporated into an agency-wide Office of Space Operations (i.e., an organization including Space Station, space transportation, and tracking and data systems operations). Specific modifications, however, would require further analysis.

It was determined that although this recommended Mature Operations Organization was readily adaptable to the requirements of all Program phases, some

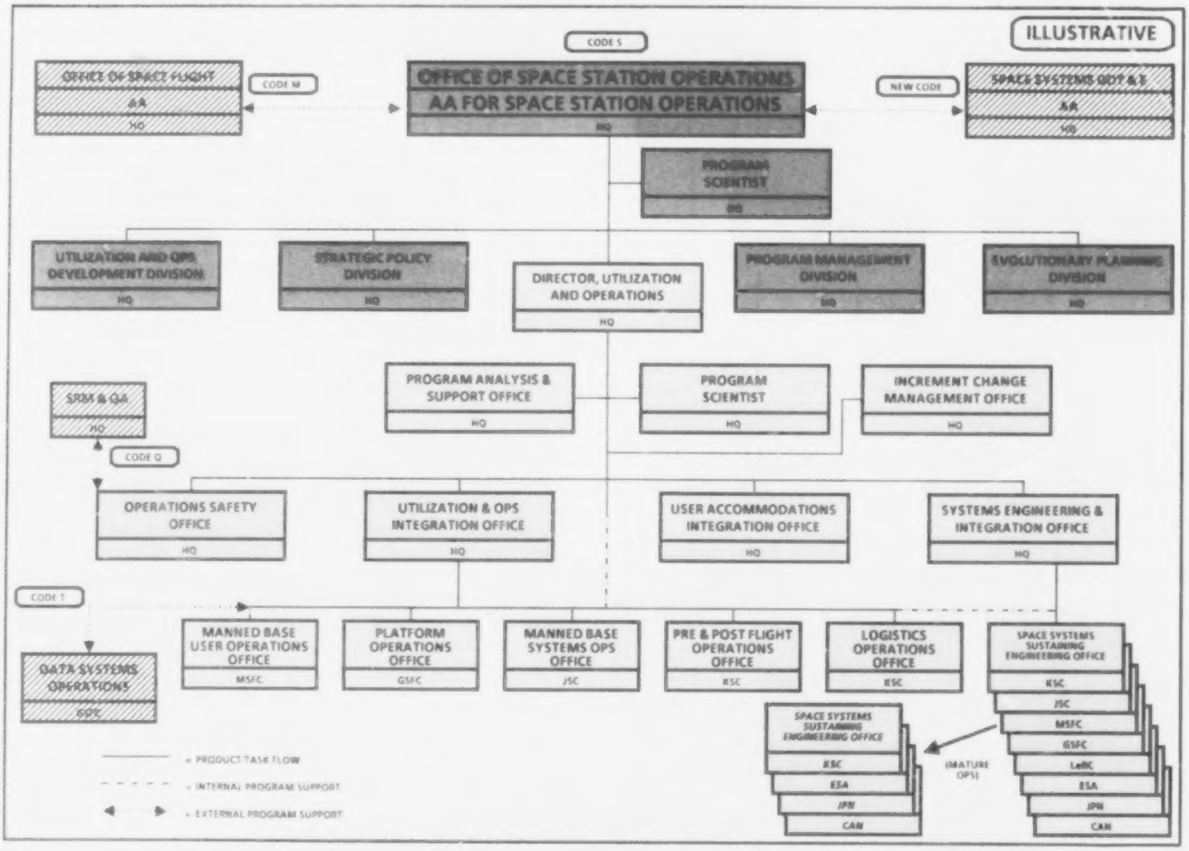
ILLUSTRATIVE
CODE S
OFFICE OF SPACE FLIGHT
AA
HQ
CODE M
OFFICE OF SPACE STATION OPERATIONS
AA FOR SPACE STATION OPERATIONS
HQ
NEW CODE
SPACE SYSTEMS DDT&E
AA
HQ
PROGRAM SCIENTIST
HQ
UTILIZATION AND OPS DEVELOPMENT DIVISION
HQ
STRATEGIC POLICY DIVISION
HQ
DIRECTOR, UTILIZATION AND OPERATIONS
HQ
PROGRAM MANAGEMENT DIVISION
HQ
EVOLUTIONARY PLANNING DIVISION
HQ
SRM & QA
HQ
CODE Q
PROGRAM ANALYSIS & SUPPORT OFFICE
HQ
PROGRAM SCIENTIST
HQ
INCREMENT CHANGE MANAGEMENT OFFICE
HQ
OPERATIONS SAFETY OFFICE
HQ
UTILIZATION & OPS INTEGRATION OFFICE
HQ
USER ACCOMMODATIONS INTEGRATION OFFICE
HQ
SYSTEMS ENGINEERING & INTEGRATION OFFICE
HQ
CODE T
DATA SYSTEMS OPERATIONS
GSFC
MANNED BASE USER OPERATIONS OFFICE
MSFC
PLATFORM OPERATIONS OFFICE
GSFC
MANNED BASE SYSTEMS OPS OFFICE
JSC
PRE & POST FLIGHT OPERATIONS OFFICE
KSC
LOGISTICS OPERATIONS OFFICE
KSC
SPACE SYSTEMS SUSTAINING ENGINEERING OFFICE
KSC
JSC
MSFC
GSFC
LeRC
ESA
JPN
CAN
SPACE SYSTEMS SUSTAINING ENGINEERING OFFICE
KSC
ESA
JPN
CAN
(MATURE OPS)
= PRODUCT/TASK FLOW
= INTERNAL PROGRAM SUPPORT
= EXTERNAL PROGRAM SUPPORT

Figure III-25 Space Station Program Mature Operations Organization

modifications will be required during the Development Phase to better focus on operational capability development and to support assembly operations planning and execution. These modifications will be described in a subsequent section in terms of specific changes to the Mature Operations Organization. The modified Transition Operations Organization structure is illustrated by Figure III-26.

Finally, the Task Force did not identify specific changes to the Mature Operations Organization required to support Space Station evolution, since this phase involves gradual development of technical operations capabilities rather than a discernable Program phase. Since evolutionary changes must be supported throughout the operational lifetime of the Space Station, the basic evolutionary operations planning and support capability must be embedded within the Mature Operations Organization infrastructure.

### III.C.2. Proposed Structure

### III.C.2.a. Mature Operations Phase Organization

This section describes the operations functions performed by each organizational element in Figure III-25. Specific recommendations regarding NASA field center operations roles are identified for each element, as are key products and interorganizational relationships. Routine organizational element functions that may be generically labeled administrative overhead[57] are not listed for each element. Organizations that are external to the Space Station Program but which provide significant support to the Space Station Operations Organization are indicated on the referenced figures; however, their specific organizational structure and functions are not described.

**(1) Program Policy Functions (NASA Headquarters):**

**Office of Space Station Operations:** This office supports the NASA Administrator in all matters pertaining to Space Station Operations. The Associate Administrator (AA) for Space Station Operations exercises overall Program management and control, and serves as principal liaison between the NASA Administrator and organizational elements of the Space Station Program. As such, the AA authorizes and controls all operations functions, products and services performed by each hierarchical element within the Program structure. As chairperson of the international Multilateral Control Board, the AA exercises Program leadership across the international

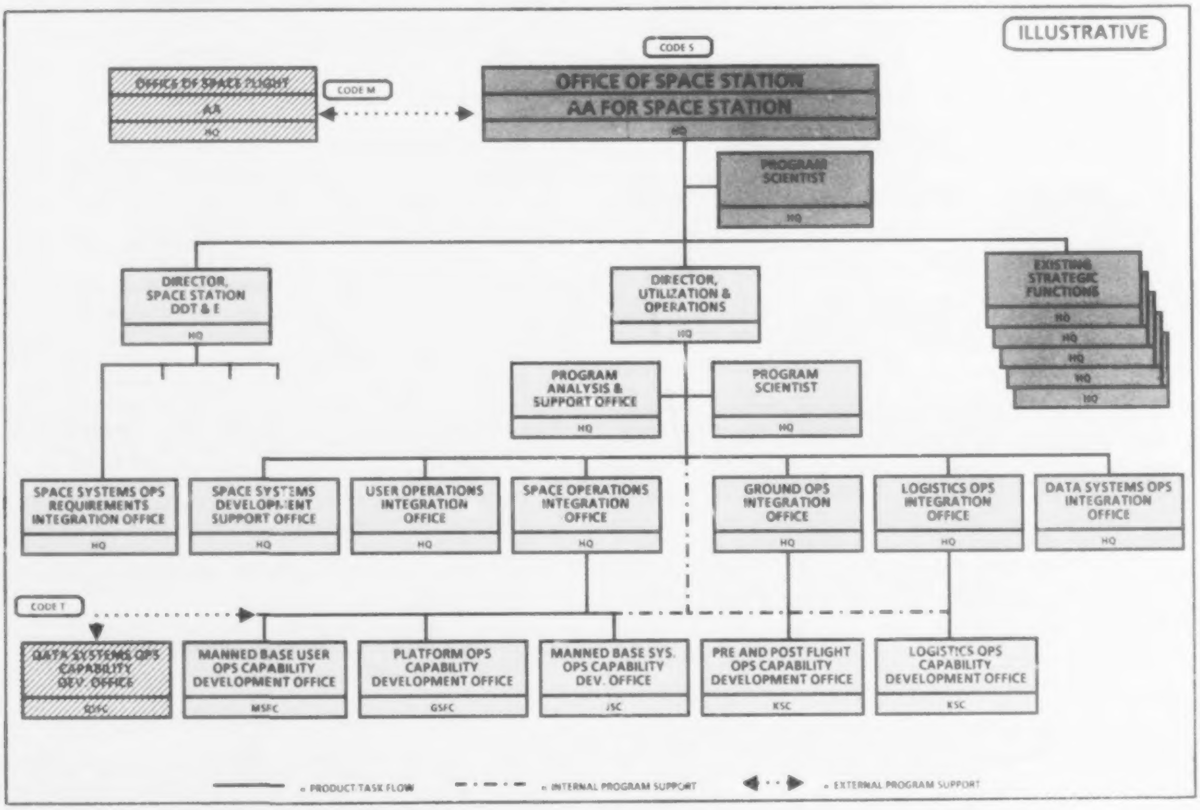
ILLUSTRATIVE
CODE S
OFFICE OF SPACE FLIGHT
AA
HQ
CODE M
OFFICE OF SPACE STATION
AA FOR SPACE STATION
HQ
PROGRAM SCIENTIST
HQ
DIRECTOR, SPACE STATION DDT & E
HQ
DIRECTOR, UTILIZATION & OPERATIONS
HQ
EXISTING STRATEGIC FUNCTIONS
HQ
HQ
HQ
HQ
HQ
PROGRAM ANALYSIS & SUPPORT OFFICE
HQ
PROGRAM SCIENTIST
HQ
SPACE SYSTEMS OPS REQUIREMENTS INTEGRATION OFFICE
HQ
SPACE SYSTEMS DEVELOPMENT SUPPORT OFFICE
HQ
USER OPERATIONS INTEGRATION OFFICE
HQ
SPACE OPERATIONS INTEGRATION OFFICE
HQ
GROUND OPS INTEGRATION OFFICE
HQ
LOGISTICS OPS INTEGRATION OFFICE
HQ
DATA SYSTEMS OPS INTEGRATION OFFICE
HQ
CODE T
DATA SYSTEMS OPS CAPABILITY DEV. OFFICE
GSFC
MANNED BASE USER OPS CAPABILITY DEVELOPMENT OFFICE
MSFC
PLATFORM OPS CAPABILITY DEVELOPMENT OFFICE
GSFC
MANNED BASE SYS. OPS CAPABILITY DEV. OFFICE
JSC
PRE AND POST FLIGHT OPS CAPABILITY DEVELOPMENT OFFICE
KSC
LOGISTICS OPS CAPABILITY DEVELOPMENT OFFICE
KSC
= PRODUCT TASK FLOW
= INTERNAL PROGRAM SUPPORT
= EXTERNAL PROGRAM SUPPORT

Figure III-26 Space Station Program Transition Operations Organization

partnership and is responsible for all decisions affecting Program direction, scope, content and safety. As a member of the Space Station Users Board, the AA represents those categories of users sponsored by the Space Station Operations Program in matters regarding specific user selection and resource allocation (mainly commercial reimbursable users). The Operations AA is the primary focal point for interface with other NASA AAs as regards their support to or interaction with the Space Station Operations Program.

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[57] *Includes organizational element resource management, product schedule development, personnel management, support contractor technical oversight and performance reporting.*

**Program Scientist:** The Program Scientist at the Program Policy level serves as a consultant to the AA on matters pertaining to:

- Domestic and international science, technology development, and commercial Space Station Program utilization opportunities;
- Liaison to various user advocacy groups;
- Support to prospective and selected users relative to their development of payload operations requirements and objectives;
- Support to evolutionary planning; and
- Serves as chairman of the Utilization Operations Panel (UOP).

**Utilization and Operations Development Division:** This office supports the AA as the SSP advocate to the user community at large. As such, the office:

- Develops and implements user outreach (marketing) strategy;
- Responds directly to user inquiries;
- Coordinates negotiation of "best efforts contracts" with prospective users or their sponsors to fly their payloads;
- Coordinates implementation of partner accountabilities and responsibilities per MOU agreements;
- Maintains a strategic operations planning "systems and services" data base containing current and projected resource availability information on transportation vehicles, the manned base, U.S. and partner platforms, OMV/FTS, and ground support facilities;
- Provides chairpersons as required to support the international Systems Operations Panel (SOP);
- Integrates and publishes the international Consolidated Utilization Plan in response to SOP and UOP requirements;
- Maintains functional descriptions of selected payloads and their operational objectives;
- Supports evolutionary planning with respect to future user requirements; and
- Leads in user selection and resource allocation for commercial reimbursable and commercial development users, and provides marketing support to other U.S. users.

**Strategic Policy Division:** This office supports the AA in the development and implementation of Space Station Program policy relative to international, domestic non-NASA and internal NASA Space Station Program operations, including:

- International partner or user Memoranda of Understanding (MOU) negotiations;
- Staffing coordination of NASA/partner international liaison offices;
- Interaction with Executive and Legislative Branch staff offices and committees;
- Interaction with non-NASA government organizations including the Department of Defense; and
- Definition of Space Station Program goals, objectives and strategic-level operational requirements.

**Program Management Division:** This office provides support to the AA in matters regarding:

- Multilateral Control Board logistics;
- Strategic operations policy analysis;
- Strategic requirements and plans control;
- Program risk assessments;
- Determination of Program operations costs;
- Development of organizational performance and cost measurement criteria and approval of techniques for assessments of overall organizational effectiveness, supportability and guidance in defining long-term Program improvements.

The office is also responsible for operations budget planning and control including.

- Coordination and support to Program Operations Plan (POP) development, defense and representation of requirements to other organizations and agencies, and oversight of program resources acquisition;
- Primary support to pricing and cost sharing policy development; and
- Program milestones development and statusing.

**Evolutionary Planning Division:** This office supports the AA in planning for Program evolution operations including:

- Definition of Program evolution goals;
- Ongoing interaction with the Program Integration and Execution levels of the organization to obtain

feedback regarding overall operations effectiveness and growth potential/needs;

- Development of evolutionary operations requirements;
- Conduct of Program Policy level planning for enhancement of ground and onboard resources;
- Management of contractor and field center studies in evolutionary operations;
- Leads in planning and control of evolutionary advanced development requirements for Space Station technology; and
- Interaction at the Program Policy level with the Evolutionary Systems Development Organization regarding implementation of evolutionary operations requirements.

**(2) Program Integration Functions (NASA Headquarters):**

**Office of the Director, Utilization and Operations:** The NASA Director, Utilization and Operations, supports the Associate Administrator and has delegated responsibility and authority to administer and control the overall Program Integration and Execute Level operations functions within the SSP. This includes:

- Control of baseline SSP orbiting and ground support elements configuration;
- Control of Program Integration Level operations requirements and plans;
- Chairing the Program Operations Control Board;
- Ensuring effective accommodation of user requirements for Program integration including Program Integration and Execution level operations planning and implementation; and
- Approval of astronauts qualified to fly on the Space Station.

**Program Scientist:** The Program Scientist at the Program Integration level serves as a consultant to the Director, Utilization and Operations on matters pertaining to:

- Domestic and international science, technology development, and commercial Space Station Program utilization opportunities;
- Liaison to various user advocacy groups;
- Support to prospective and selected users relative to their development of payload operations requirements and objectives;
- Support to evolutionary planning; and
- Review and assessment of current SSP laboratory procedures and practice.

**Program Analysis and Support Office:** This office provides support to the Director, Utilization and Operations in matters regarding budget administration and cost control including:

- POP construction and defense;
- Program resource management;
- Support to pricing and cost-sharing policy development;
- Operations cost model development and analysis; and
- Analysis of life cycle cost trades.

The office also provides administrative support in areas of:

- Program schedules development and analysis;
- Program Support Contract management, performance measurement and award fee assessment;
- Support to Program Operation Control Board logistics;
- Configuration control of Program documentation; and
- Maintenance of a Program Documentation Library.

**Increment Change Management Office:** This office provides support to the Director, Utilization and Operations, and has the delegated responsibility and authority to manage manned base/platform Program Integration level preflight operations planning functions at the Increment Planning level. This office provides a cadre of Increment Managers to direct the unique operations planning aspects (systems maintenance, new payloads, servicing requirements, transportation systems interface including ELV visits, etc.) associated with each flight increment. Increment Managers steer utilization of manpower and funding resources available for their increment, and provide feedback to institutional support organizations relative to the performance of planning support personnel and operations support systems. This office will be staffed by senior operations personnel and may have international partner representatives in Increment Manager positions.

**Operations Safety Office:** This office provides Program Integration Level support to the Director, Utilization and Operations, in areas involving:

- Management of SSP and payload development and operations safety standards (including requirements definition, implementation strategy development, compliance assessment, and formulation of waiver recommendations to the Director);
- Occupational health standards implementation and monitoring;
- Review of/concurrence with Increment Hazard Control Plans;

- Certification of S&T Centers as qualified safety inspection sites;
- Review of/concurrence with onboard operations plans and procedures relative to compliance with approved safety standards, including those relating to crew safe haven provisions;
- SSP interface with the NASA Office of Safety, Reliability, Maintainability, and Quality Assurance;
- Coordination of the SSP Program Safety Review Board (PSRB) schedules, agendas, and minutes. (The PSRB is chaired by the aforementioned SRM & QA Office);
- SSP interface with the Office of Space Flight relative to matters involving Station crew rescue;
- STS/SSP representation at NASA safety reviews; and
- Provide chairpersons for the Systems Safety Panel and the Payload Safety Panel.

**Utilization and Operations Integration Office:** This office provides support to the Director, Utilization and Operations, in areas including:

- Centralized management of overall space operations, space operations support, and logistics operations support across participating NASA and international partner centers of expertise;
- Configuration control of the Mission Requirements Data Base, containing technical systems and operations data on each payload recommended by the SSUB and accepted by the SSP for flight;
- Coordination of the acquisition of appropriate user/space systems data from within the various NASA and partner support centers to complete the required Payload Integration Plan (PIP) Annex-type documentation for each accepted user's payload;
- Development of payload increment manifest recommendations and coordination assessments with other Program and institutional-level organizations;
- Development of Station and platform Tactical Operations Plans;
- Support development of Station Increment Hazard Control Plans;
- Coordination of the development, planning and analysis of integrated logistics requirements;
- Provision of chairpersons as required to support the international Systems Control Panel (SCP) and Utilization Control Panel (UCP) functions; and
- Configuration control of the various planning data bases used to support tactical and execute-level space operations, space operations support and logistics operations support planning.

**User Accommodations Integration Office:** This office provides support to the Director, Utilization and Operations, in the area of user integration into the Program. The office provides a cadre of Payload Accommodation Managers (PAM's), one to be assigned to each user accepted by NASA for participation in the SSP. The PAM's primary responsibility is to serve as the user's advocate to the Program. PAMs will also support the Systems Engineering and Integration Office (the SSP agent for transportation system Program interface) relative to payload PIP requirements on/from the affected transportation system. Additionally, this office will support the Utilization and Operations Development Division in development of SSP marketing materials and in analysis of Consolidated Utilization Plan data.

**Systems Engineering and Integration Office:** This office provides engineering integration support to the Director, Utilization and Operations, in the centralized management of space systems sustaining engineering across the various NASA and international partner development centers. The office orchestrates the baseline systems configuration control process for the Director including:

- Coordination of Architectural Control Documents and Baseline Configuration Documents maintained by the assigned development centers;
- Review and classification of baseline systems modification requests and coordination of related engineering analyses;
- Maintenance of integrated systems performance models and data bases; and
- Management and control of an integrated space systems maintenance plan.

In addition to these configuration control functions, the office also:

- Provides support to the Program Policy Level utilization, operations and evolutionary planning functions;
- Serves as the Program interface to the NASA Development Organization (external to Office Of Space Station Operations);
- Manages and controls overall SSIS/SSE/TMIS architecture and space/ground systems interface requirements;
- Manages and controls the NASCOM/SN/PSCN and TDRSS program interface requirements (excluding network scheduling which is integrated by the Utilization and Operations Integration Office);
- Manages and controls real-time data processing (level zero) and distribution requirements for space and user systems;

- Manages and controls implementation plans and schedules regarding the eventual centralization of sustaining engineering functions at KSC;[58] and

- Serves as the Program interface to the various transportation system program(s) relative to provision and coordination of all space and user systems PIP, Annex, and ICD data required of the SSP by the affected transportation systems programs.

**(3) Program Execution Functions (NASA Field Centers):**

**Manned Base User Operations Office (MSFC):** This office coordinates MSFC manned base space operations Program support activities in the principal area of user Program Execution Level operations planning and real-time support. In addition, the office provides ongoing support to the Headquarters Utilization and Operations Integration Office in performing international Payload Operations Integration Center (POIC) activities at MSFC. This support may routinely include coordination and statusing of the following POIC activities:

- Support to the various NASA codes and international partner organizations relative to payload operations feasibility assessments;

- Preflight and real-time accommodation of Space Station Users Working Group (SSUWG) and Investigators Working Group (IWG) personnel as required to support tactical-level utilization operations planning and perform execution-level utilization operations planning;

- Performance of payload-to-manned base operations integration and analyses;

- Acquisition of user operations requirements and development of associated PIP Annexes;

- Support to user development of ground and onboard payload operations procedures;

- Coordination of part-task and integrated payload operations crew training in the MSFC Payload Training Integration Facility (PTIF);

- Interface with the JSC Space Station Support Center (SSSC) relative to acquisition of space systems resource templates and concurrence on matters of crew safety;

- Coordination of Program payload servicing support requirements and analyses;

- Consistent with the Tactical Operations Plan, development of integrated user operations timelines at the flight increment level;

- Support to SSSC development of the Increment Hazard Control Plan;

- Real-time support to the onboard crew including monitoring of critical payload and user support equipment data;

- Support to payload operations replanning and contingency operations; and

- Coordination of network scheduling relative to payload data acquisition and distribution.

Additionally, this office will coordinate the maintenance, operation and sustaining engineering for all MSFC facilities and equipment supporting POIC operations (including Technical Management and Information System [TMIS] equipment). This includes performance and trends analysis, design engineering, engineering integration and verification, support systems configuration management, maintenance and operations (M&O) procedures development and personnel training, verification and control, implementation schedules development, and performance of M&O functions.

**Platform Operations Office (GSFC):** This office coordinates GSFC space operations Program support activities involving U.S. polar and co-orbiting platforms Program Execution Level operations planning and real-time support. It provides ongoing support to the Headquarters Utilization and Operations Integration Office in performing payload Platform Support Center (PSC) activities at GSFC. This support may routinely include coordination and statusing of the following PSC activities:

- Support to the various NASA codes relative to payload operations feasibility assessments;

- Preflight and real-time accommodation of Space Station Users Working Group (SSUWG) and Investigators Working Group (IWG) personnel as required to support Program Integration Level utilization operations planning and perform Program Execution Level utilization operations planning;

- Performance of payload-to-platform operations integration and analyses;

- Acquisition of user operations requirements and development of associated PIP Annexes;

- Support to user development of ground operations procedures

- Development, validation and configuration control of platform operations and servicing procedures;

- Consistent with the Tactical Operations Plan, development of integrated platform operations Execute Plans;

- Provision of support to STS and manned base crew training in platform servicing techniques;

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[58] *It is an SSOTF recommendation to consolidate all space systems sustaining engineering at KSC following the stabilization of orbital systems operations performance and achievement of a high degree of overall Program maturity.*

- As required to support STS or Manned Base servicing operations, provision of real-time support to the onboard crew including management and control of hazardous commands;

- Monitoring of critical platform systems and user systems data;

- Support to payload operations replanning and contingency operations;

- Coordination of network scheduling relative to platform and user systems data acquisition and distribution; and

- Ground operator training.

Additionally, this office will coordinate the maintenance, operation and sustaining engineering for all GSFC facilities and equipment supporting PSC operations (including TMIS equipment). This includes performance and trends analysis, design engineering, engineering integration and verification, support systems configuration management, M&O procedures development and personnel training, verification and control, implementation schedules development, and performance of M&O functions.

**Manned Base Systems Operations Office (JSC):** This office coordinates JSC space operations Program support activities involving Manned Base Program Execution Level operations planning and integration, flight crew interface with Manned Base space and user systems, flight crew safety and health considerations, and flight crew training. It provides ongoing support to the Headquarters Utilization and Operations Integration Office in performing Space Station Support Center (SSSC) activities at JSC as well as activities involving flight crew training at JSC and other NASA and international partner centers. This support may routinely include coordination and statusing of the following SSSC activities:

- Support to payload operations feasibility assessments and analyses, especially with regards to onboard safety;

- Support to Manned Base manifest assessments;

- Support to Program Integration Level operations and maintenance planning and performance of Program Execution Level space systems operations and maintenance planning;

- Interface with the POIC relative to acquisition of user operations requirements and concur in matters of payload operations safety;

- Performance of integrated user and space systems operations execution planning;

- Performance of space systems operations and performance analyses;

- Development, validation and configuration control of space systems operations procedures and flight techniques;

This office will also coordinate the planning and execution of all Manned Base flight crew and supporting ground operator space systems training activities as distributed across the Program (See training discussion in Section IV.H.) and ensure that the various simulators and trainers are maintained in an appropriate configuration. Additionally, it will serve as the requirements focal point for flight crew interface with space and user systems. As such, it will advocate and administer standards relating to systems design as well as those which facilitate safe and effective operations. Finally, this office will coordinate the maintenance, operation and sustaining engineering for all JSC facilities and equipment supporting SSSC and crew training operations (including TMIS equipment). This includes performance and trends analysis, design engineering, engineering integration and verification, support systems configuration management, M&O procedures development and personnel training, verification and control, implementation schedules development, and performance of M&O functions.

**Pre and Post Flight Operations Office (KSC):** This office coordinates KSC manned base and platforms space operations Program support activities in launch site processing integration of space-bound cargo. It provides ongoing support to the Headquarters Utilization and Operations Integration Office in performing Space Station Processing Facility activities at KSC. This support may routinely include coordination and statusing of the following space systems and user systems integration activities:

- Development of cargo processing schedules, flow templates and operating plans;

- Development, validation and configuration control of processing standards and procedures;

- Transportation system launch site interface;

- User launch site interface;

- International partner launch site interface;

- Attached payload interface testing and verification;

- Support to space systems on-orbit maintenance analyses;

- Consistent with the Tactical Operations Plan, development of the various timeline, flight rule, and safety related increment execution documentation including the Increment Hazard Control Plan;

- Provision of real-time support to the onboard crew including management and control of hazardous commands and monitoring of critical space systems and user systems data;

- Support to Manned Base operations replanning and contingency operations; and

- Coordination of network scheduling relative to space systems data acquisition and distribution.

- Experiment-to-rack interface testing and verification (also performed at Science and Technology Centers);
- Rack-to-element interface testing, verification and flight certification;
- ORU-to-element interface testing, verification and flight certification;
- Postflight cargo deintegration;
- Hardware recertification for flight;
- Coordination of late pad access and early landing site retrieval requirements; and
- Ground personnel training.

Additionally, this office will coordinate the maintenance, operation and sustaining engineering for all KSC facilities and equipment supporting cargo processing operations (including TMIS equipment). This includes performance and trends analysis, design engineering, engineering integration and verification, support systems configuration management, M&O procedures development and personnel training, verification and control, implementation schedules development, and performance of M&O functions.

**Logistics Operations Office (KSC):** This office coordinates KSC Program support activities in the principal area of Integrated Logistics System (ILS) services for space-bound cargo. It provides ongoing support to the Headquarters Utilization and Operations Integration Office in performing Logistics Operations Center activities at KSC. This support may routinely include coordination and statusing of the following space systems and user systems logistics integration activities:

- Coordination of ongoing ILS analyses by MSFC (part of MSFC's space systems sustaining engineering function);
- ORU spares procurement, repair and inventory management, and supply support;
- Development, validation and configuration control of ILS standards and procedures;
- Ground transportation and handling of cargo elements and components including postflight distribution, following space transportation system deintegration;
- ILS personnel training;
- Ground support equipment acquisition;
- Space and user systems mass and volume data base management and control;
- Resupply and return manifest development, management and control for Program logistics carriers; and,
- Configuration management of ORU, crew systems, and user systems onboard stowage.

Additionally, this office will coordinate the maintenance, operation and sustaining engineering for all facilities and equipment supporting Logistics Operations Center and ILS operations (including TMIS equipment). This includes performance and trends analysis, design engineering, engineering integration and verification, support systems configuration management, M&O procedures development and personnel training, verification and control, implementation schedules development, and performance of M&O functions.

**Space Systems Sustaining Engineering Offices (HQS, MSFC, JSC, GSFC, LeRC, KSC, Canada, ESA, Japan):** Each NASA and international partner center's office coordinates the ongoing sustaining engineering associated with its assigned space systems. (See Table III-8.) for the manned base and platforms. In performing their sustaining engineering functions, each office provides ongoing support to the Headquarters Systems Engineering and Integration Office. This support may routinely include coordination and statusing of the following space systems sustaining engineering activities:

- Systems performance and trends analysis;
- Design engineering (including appropriate interface with the Development organization external to the Office of Space Station Operations);
- Engineering integration and verification;
- System configuration management;
- Definition of requirements for delegated space systems maintenance;
- Technical systems operations procedures development and validation;
- Support to the Headquarters configuration control process; and,
- Systems upgrade and maintenance schedules development.

Additionally, the KSC Office will coordinate the development of space systems ORU manifests, manage any launch site ORU maintenance and modifications, develop and manage generic sustaining engineering standards and processes, and develop and manage a configuration data base on each space system and subsystem ORU. Finally each office will coordinate the maintenance, operation and sustaining engineering for all supporting ground facilities and equipment (including TMIS interfaces) in much the same manner as it supports its space systems sustaining engineering functions.

### III.C.2.b. Development Phase

This section describes the modifications to the Mature Operations Organization necessary to meet the requirements of the Development Phase. This structure is designed to effectively manage and control

| RESPONSIBLE CENTER | CATEGORY | AREA OF RESPONSIBILITY |
|---|---|---|
| HQS | D | • Integration of distributed sustaining engineering activities |
| | D | • Technical Documentation Configuration Control<br>• Integrated Elements<br>• Integrated Space Systems<br>• Sustaining Engineering Standards |
| | D | • Coordination of baseline space systems and GFE support systems configuration control process |
| | D | • Integrated maintenance data base control |
| | D | • Development, management and control of an integrated space systems maintenance plan |
| | D | • Development and implementation (following Program maturity) of a sustaining engineering consolidation plan |
| MSFC | A,B | • Onboard space systems as follows:<br>• Structures<br>• Core Modules<br>• Racks<br>• Logistics Modules<br>• Connect/Interconnect Apparatus<br>• Systems<br>• Environmental Control and Life Support (End-To-End System)<br>• Thermal (Internal System)<br>• Communication and Tracking (Internal System)<br>• Data Management (Internal System)<br>• Power Management and Distribution (Internal System)<br>• Outfitting<br>• U.S. Laboratory Module<br>• Habitation Module<br>• Logistics Module |
| | A,B | • Integrated Logistics System |
| | | • Orbital Maneuvering Vehicle (OMV) |
| | A,B | • OMV-To-Mobile Servicing Center (MSCS) |
| | A,B | • OMV-To-Station/Platform Systems |
| | C | • OMV-To-Payload Systems |
| JSC | A,B | • Onboard space systems as follows<br>• Structures<br>• Truss<br>• STS Interface/Berthing Mechanism<br>• Mobile Transporter<br>• Airlocks<br>• Nodes<br>• Systems<br>• Data Management<br>• Communications and Tracking<br>• Guidance, Navigation and Control<br>• Thermal Control System<br>• Propulsion<br>• EVA Systems<br>• Resource Integration<br>• Crew |
| | C | • Pressurized volume payloads-to-Station |
| GSFC | A,B | • Platform Structures and Systems (Except Power) |
| | A,B | • Servicing Facility |
| | A,B | • Attached Payload Accommodations |
| | A,B | • Servicing Tools |
| | A,B | • Flight Telerobotic Servicer (FTS) |
| | C | • Payloads-To-FTS |
| | C | • Attached Payloads-To-Station |
| | C | • Payloads to servicing facility |
| | C | • Payloads-To-U.S. Platform |
| LeRC | A,B | • Onboard Space Systems As Follows:<br>• Photo Voltaic Module<br>• Solar Dynamics Module<br>• Station Power Management and Distribution<br>• Platform Power |
| KSC | A | • Launch site maintenance and modifications to space systems ORU's |
| | A | • Engineering analyses of logistics operations and prelaunch/postlanding operations processes in support of effective handling of space systems ORU's and supporting GFE |
| | A | • ORU up/down manifest development and coordination with the transportation system organization |
| | A | • As a delegated task from the program integration organization, development of generic standards for space systems sustaining engineering for use by all distributed ESC's |
| | A | • Development and management of a configuration status and maintenance history data base for each space system ORU |
| Canada | A,B | • MSCS |
| | C | • MSCS-To-Payload |
| ESA | A,B | • Columbus lab and associated space system |
| | C | • Pressurized Volume Payloads-To-Columbus Module |
| Japan | A,B | • Japanese Experiment Module/Exposed Facility/Experiment Logistics Module and associated space systems |
| | C | • Pressurized volume payloads-to-Japanese Experiment Module/Exposed Facility/Experiment Logistics Module |

* A = Maintenance Engineering Responsibility
* B = Design Engineering Responsibility
* C = Payload Integration Responsibility
D = Sustaining Engineering Integration Responsibility

* Reference section III.B.2, Engineering Support Operations, for category definitions.

Table III-8 Space Systems Sustaining Engineering Responsibilities

the development of a diverse and user-oriented Program operations capability. Further, it supports the complex assembly and verification process and allows for special Program emphasis in areas where operations advocacy at a visible organizational level is important during development. Finally, it facilitates gradual "organizational transition" to the structure recommended for the Mature Operations Phase as the Station elements are assembled and verified.

Where no specific mention is made below of organizational elements appearing in the Transition Operations Organization diagram (see again Figure III-26), the reader should assume that the affected element's operational support functions are essentially the same as defined for Mature Operations. Of course, there will be a slant towards development of the capability to perform those functions rather than of routine mature operations support:

**(1) Program Policy Functions (NASA Headquarters):**

The SSOTF assumed that the existing Office of Space Station would create and provide Program Policy level management for the Transition Operations Organization. Strategic planning functions for the Development Phase are essentially the same as for the Mature Operations Phase, but emphasize the development of an initial utilization and operations capability and defining discipline-generic user requirements (as opposed to defining specific user marketing strategies, evolutionary planning, etc.). The various NASA and partner operations agreements will be established through this level of the Transition Organization. As currently defined within the Office of Space Station (Figure III-27), the operations-related organizational elements (including user-oriented elements) appear adequate to support Program Policy level transition planning at this stage of Program development. However, as noted above, the SSOTF believes that the Operations Organization should be separated from the Space Station Development Organization during the Development Phase.

**(2) Program Integration Functions (NASA Headquarters):**

The **Increment Change Management Office** will not be required in the early Transition Organization; however, this office must be in place and organized two years before the first element launch to oversee detailed operations planning unique to each assembly and verification mission (analogous to a mature operations "increment").

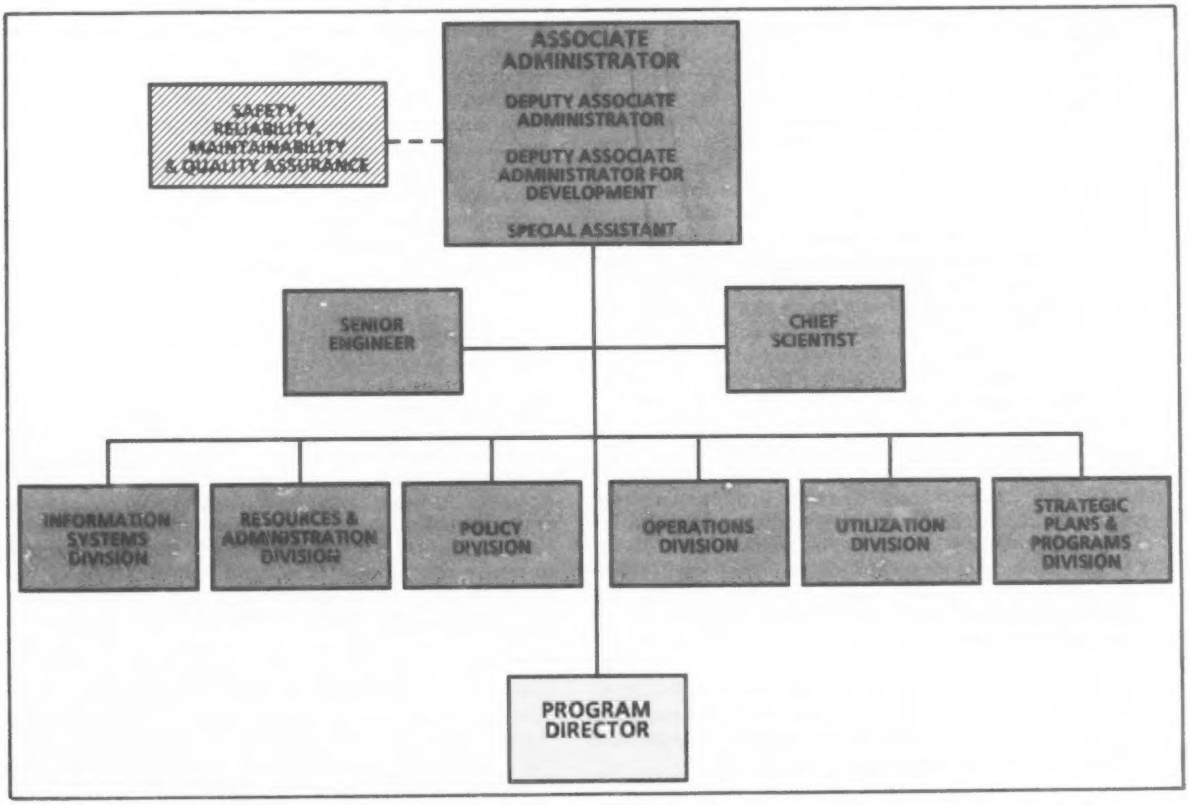
ASSOCIATE ADMINISTRATOR
DEPUTY ASSOCIATE ADMINISTRATOR
DEPUTY ASSOCIATE ADMINISTRATOR FOR DEVELOPMENT
SPECIAL ASSISTANT
SAFETY, RELIABILITY, MAINTAINABILITY & QUALITY ASSURANCE
SENIOR ENGINEER
CHIEF SCIENTIST
INFORMATION SYSTEMS DIVISION
RESOURCES & ADMINISTRATION DIVISION
POLICY DIVISION
OPERATIONS DIVISION
UTILIZATION DIVISION
STRATEGIC PLANS & PROGRAMS DIVISION
PROGRAM DIRECTOR

Figure III-27 NASA Headquarters
Office Of Space Station Organization (Code S)

The **Space Systems Development Support Office** will serve as liaison to the space systems Development Organization. It will be responsible for ensuring that the Development Organization fully integrates operational requirements into their Space Station systems engineering activities. It is recommended that the Development Organization have an analogous office (depicted in Figure III-26 as the Space Systems Operations Requirements Integration Office), specifically responsible for the integration of these requirements into space systems designs.

During the Development Phase, there will be no dedicated **Operations Safety Organization** at the Program Integration Level. The Office of Space Station has established the appropriate interfaces with the headquarters Office of Safety, Reliability, Maintainability and Quality Assurance (Code Q) to ensure safe systems design during the Development Phase. Furthermore, there will not be enough payload systems design and operations details available to justify a dedicated payload safety integration office. Finally, it will be some time before there are dedicated ground facilities operating on behalf of the Space Station Program. (Their development is to be certified safe by their respective institutional organizations.) As specific payloads are selected and funded for participation in the Program, and as support facilities are developed and enter their operations capability certification and assembly operations support stage, a dedicated safety operations integration function will certainly be justified.

The utilization and operations functions have not yet been combined in this Transition Organization concept. The SSOTF judged that at least until the Space Station Users Board, the Utilization Operations Panel and the Space Station Users Working Group are formed and their respective functions assumed, the Program should continue to organizationally provide for specific user advocacy. Such advocacy ensures that all avenues for user access to the Program are fully supported, and there is continued objective critique of overall systems design and operations capability development to support the NASA goal of providing a user-friendly Station Program. Hence, the User Operations Integration Office is kept separate

Additionally, since it will be some time before significant numbers of specific users are selected and funded for Program participation (and hence, few requirements for dedicated Payload Accommodation Managers), there is not yet a requirement for a dedicated user accommodations function within the Transition Organization. Any early requirements for user integration will be handled by the User Operations Integration Office.

The SSOTF judged that the scope and complexity of activities associated with development of an integrated logistics capability warranted a separate integration office at NASA Headquarters.

The long term supportability of the Station Program will be determined in large part by the success of the logistics integration activities during the Development Phase. One of the key determinants of life-cycle-cost is the systematic implementation of Program policies regarding commonality, reliability and maintainability. The efforts of a Program Integration level office will be required to maintain adequate development funding to define and implement these policies across the Work Packages and to oversee the development of the information systems and management infrastructure necessary for mature logistics operations. Hence, the Transition Organization includes a Ground Operations Integration Office and Logistics Operations Integration Office as organizational elements at the Program Integration level.

Likewise, the task of focusing the operations requirements regarding overall architectural design and implementation of the Space Station Information System (SSIS), with its numerous ground and onboard components, is large enough in scope to justify a dedicated Program integration function. Hence, the Transition Organization includes a Data Systems Operations Integration Office as an organizational element. Additional responsibilities of this office are to integrate the ground operations requirements associated with the development of the Software Support Environment (SSE) and the Technical Management and Information System (TMIS), each required to complement the end-to-end SSIS network operations.

During the early-to-mid Development Phase, there is no requirement for a dedicated space systems sustaining engineering integration function since the various elements and systems are still the responsibility of the Development Organization and its associated work packages and prime contractors. However, as the Space Station is gradually assembled and its components verified, the work package development centers will transition their respective space systems' sustaining engineering responsibilities to the Operations Organization. Therefore, a systems engineering and integration function must be in place at Headquarters in time to effect a smooth handover.

### (3) Program Execution Functions (NASA Field Centers):

With the exception of the Engineering Support Centers, all field center organizations will support the same operational areas during the Development Phase as they do during the Mature Operations Phase. However, functional emphasis will vary over the course of the transition period, from support facilities/systems requirements and implementation plans development; to construction, outfitting and certification of the facilities/systems; to direct support of Space Station assembly and operations verification.

The MSFC, JSC, and GSFC operations capability development field offices depicted on Figure III-23 provide routine Program support through the Headquarters Space Operations Integration Office; the KSC Pre and Post Flight Operations Capability Development Office provides routine support through the Headquarters Ground Operations Integration Office and the KSC Logistics Operations Capability Development Office provides routine support through the Headquarters Logistics Operations Integration Office.

As discussed earlier, the **Engineering Support Centers** responsible for space systems sustaining engineering during the Mature Operations Phase will not become a part of the Operations organization until after each center's delegated space systems have been delivered to orbit and operationally verified. At that time, the responsibility for sustaining engineering will be handed over to the Engineering Support Center at that field center.[59]

## III.D. THE USER INTEGRATION SCENARIO: ILLUSTRATING THE OPERATIONS FRAMEWORK

As part of the final concept verification effort, the Task Force developed a scenario illustrating the process by which a user's payload and operations are integrated into the Space Station Program. The effort resulted in detailed user integration "flow charts" (enclosed separately) demonstrating the activities and milestones involved in the process, and a narrative of this flow.

There were several goals for this effort: (1) to assist in the consolidation of the concepts developed by the individual panels into one coherent operations concept; (2) to ensure that these concepts were mutually consistent and supportive; (3) to verify that the concepts provided for a consistent and complete user integration process; and (4) to ensure that this process is "user friendly" and can accommodate the divergent needs of users from different functional and demographic groups.

The scenario falls into three sections: the first section traces a single "generic" manned-base user through the user integration process. Differences in the flow for users with special requirements -- particularly between "regular" and "quick is beautiful" users -- are pointed out where applicable. The second section traces the development of a new platform; the third section, the addition of new payloads to an existing platform. The scenario was assumed to take place during the Mature Operations Phase of the Space Station Program (SSP). It is assumed that a "normal" crew complement is available to handle payloads, and that no evolutionary changes to the Station are planned for this time.

### III.D.1. Manned Base Operations Flow

#### Summary

The scenario begins with the distribution of Space Station resources to the international Space Station partners, then outlines the process by which U.S. resources are distributed among the major user groups. (See Figure III-28 for a summary version of the user integration flow.) From this point on, the scenario traces a single generic user through payload selection, definition, development, planning, operations and post-operations activities.

Different payload sponsors will vary as to their payload selection procedures; however, this process begins when a sponsor (usually a NASA office) solicits investigators to propose payloads to accomplish the sponsor's goals within the sponsor's resource allocation. The user submits a proposal, which is reviewed by the sponsor and, typically, by a peer review group. Having passed this review, the sponsor provides a list of candidates via the Space Station User Board (SSUB) to the Office of Space Station Operations (OSSO), which performs a feasibility assessment to ensure that the payload can be accommodated on the Station. The results of this assessment are provided to the sponsor. Based on the peer review and the feasibility assessment, the sponsor selects users. These users' requests for flight are submitted to the SSUB for coordination into the five-year Consolidated Utilization Plan (CUP).

At this point, the user is ready to begin payload definition and design work. At several points during this process, OSSO conducts reviews (including a multiple-phase safety review) to support planning efforts and to ensure compliance with Station standards. These reviews support the payload-to- Station integration process, providing data for the Interface Control Documents (ICDs), Payload Integration Plans (PIPs), and the Annexes to the PIPs.[60] At about two years before launch, typically around the time of payload Preliminary Design Review (PDR), the user's payload is entered into the Tactical Operations Plan, assigning the payload to a specific flight increment. The user completes payload definition, participates in operations planning efforts, and conducts or supports crew training and simulation efforts.

Approximately six months before launch, the payload is delivered to the Space Station Program for final integration, testing and verification prior to launch. It is launched by the Office of Space Flight and integrated into the Station by the Space Station crew. The user participates in on-orbit check-out and commences user operations. As long as the payload is onboard the Station, the user participates in daily planning (called "replanning") with other users, and operates and monitors his payload and crew operations relating to it. Onboard activities may be performed by a user-sponsored astronaut who has trained and operates as a member of the crew. When his operations are completed, the user shuts down the payload, the crew deintegrates it, and it is returned to earth. The user retrieves his hardware and/or any other materials or data, then completes his participation in the program by debriefing the offices that have been involved in accommodating him throughout the user integration process.

The following sections illustrate the manned base user flow in greater detail, and refer to the complete flowchart associated with this volume.

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[59] *The ESCs may very well consist of the same personnel reporting to a different parent organization.*

[60] *These names refer to documents used in the STS program; the STS names are used here to indicate that the Station documentation will be equivalent in nature and purpose. The names may or may not be the same.*

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Chart Transposed to
End of Volume.

### Initial Distribution of Resources to Partners and Disciplines

Before specific users can be selected, Station resources must be distributed among the various partners and user sponsors. The Multilateral Control Board (MCB) will divide among the partners the total Station resources available to users (as opposed to those required to maintain the Station and crew). Based on information provided by the OSSO Utilization and Operations Development Division (UODD), the MCB's Systems Operations Panel (SOP) will provide the MCB with a projection of Station resources available to users over the coming five years. The MCB will review this projection in light of the MOU agreements, and notify the partners of the resources available to each.[61]

Each partner will be free to select users as it sees fit within the resource envelope allotted to it. In the U.S., a Space Station User Board (SSUB), consisting of representatives of each class of user, will divide the U.S. allocation among the disciplines that use the Station. Currently, these classes are expected to include science and applications research, technology development, cooperative commercial (i.e., those performing R&D activities under cooperative agreements with NASA), commercial reimbursable users (i.e., those who will pay their own way on the Station), and other non-NASA government agencies -- primarily NOAA and DOD. These user class allocations will be reviewed and reworked by the SSUB as new types of users emerge.

With the exception of the non-NASA government users, each user class will be assigned a sponsor Program Office within NASA. This sponsor will represent that user class on the SSUB, and will be free to distribute its resource allocation as it sees fit to users within that class. For space science or application users, the sponsor will be Code E, the Office of Space Science and Applications. The Office of Aeronautics and Space Technology, Code R, will sponsor technology development users. Commercial cooperative users will be sponsored by Code I, the Office of Commercial Programs. Reimbursable commercial users will be the responsibility of the Office of Space Station Operations (OSSO) itself, unless they prefer to come through one of the other codes. Other government agencies (e.g., DOD and NOAA) will represent themselves on the SSUB.

### Marketing/User Development

The UODD will perform a general Program marketing function: conducting conferences, publishing articles and brochures, and otherwise alerting the potential user communities of the Program's availability and capabilities. However, the various user sponsors will bear primary responsibility for marketing to users within their assigned classes. After they have been notified of their resource allocation, the sponsor codes will obtain budget authority for new payloads or programs utilizing the Station.[62] The sponsors will then solicit investigators via announcements of opportunity (AOs) or other means. These solicitations could be proposed or handled by Science and Technology (S&T) Centers, which have developed expertise in a particular area of Space Station utilization (e.g., materials or life sciences).[63] UODD will assist the sponsors by providing specific cost and technical information, and will develop standardized forms for user/Station agreements.

A commercial reimbursable user (i.e., whose payload will not be funded by NASA) may learn of opportunities on the Station through UODD, Office of Commercial Programs or other sponsor outreach activities (conferences, target visits, advertising, articles in the trade and general press); through an existing contact within a NASA office; or may contact the Office of Space Station Operations at his own initiative. If the user does not initially contact the appropriate sponsor, he will be referred to one for further information.

Contracts with and support to DOD, NOAA or other non-NASA government users will be handled by UODD.

### Payload Selection and Inclusion in the CUP

Once a user has indicated a preliminary interest in the Program, his NASA sponsor will encourage him to submit a formal proposal. If necessary, the UODD will assist him by providing Station information and requirements. His proposal will then undergo a series of reviews to determine its compatibility with the sponsor's goals; with the goals, capabilities and constraints of the Space Station Program; and with the resource allocations laid out by the SSUB and MCB.

The user's proposal will first be reviewed by the sponsor office to ensure that it meets the goals of the solicitation to which it responds. Reimbursable users will be reviewed only to ensure that the payload will not contravene any limitations placed on Space Station activities (by treaty, MOU or U.S. policy, or by safety constraints). The SSUB will review the payloads that have passed this milestone, and provide candidate payload information to the UOIO. The UOIO will use this information to perform a feasibility assessment to ensure the payload's compatibility with Station systems and operations. Institutional operations offices will support this assessment as necessary to verify that the candidate payload will meet crew interface and safety standards and can be supported by the logistics, transportation and information systems.

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[61] *The SOP and UOP are internationally staffed and provided for in the MOUs between the U.S. and its partners.*

[62] *The relevant NASA user sponsors may subdivide their resource allocations into sub-blocks allotted to their component disciplines (e.g., micro-gravity, astrophysics, robotics, structures, etc.) and request funding based on these sub-allotments.*

[63] *The S&T Centers will be established and funded by the Codes and other sponsors, and will be located at NASA or partner field centers (or elsewhere) to support and take advantage of existing centers of expertise.*

The SSUB will then provide the results of the feasibility review and preliminary user definition activities back to the sponsors. The Codes then formally select the payloads they plan to sponsor. Following selection, the user prepares a Request for Flight (RFF), which is similar to the STS Form 1628.[64] The RFF will outline the user's anticipated demand for Station resources, the location of the payload on the Station, the desired flight date(s), and payload priority. For commercial users, the RFF will also cover insurance provisions, the involvement of a Payload Scientist on board the Station, and any other issues which must be considered to permit planning and pricing of the activities. The sponsor provides the user with a "best efforts" commitment to the costs which the user must pay for access to the Station.[65] The user will also review the restrictions and requirements that the SSP will impose on his payload and activities.

The SSUB examines the total payload complement selected by each sponsor to ensure that the total resource requirements do not exceed the resources allocated to that sponsor's class.[66] If all sponsors' selections are within their allotments, the SSUB forwards the combined complements to the User Operations Panel for consolidation with payloads approved by the other Space Station Partners.[67] With the support of the UODD, the UOP will combine all of the selected payloads into the CUP and forward it to the MCB for final approval. The CUP will list all of the major utilization and operations activities planned for the Station over the next five years, and will assign payloads to a particular year and quarter. (It will not assign the user to a particular flight increment.) The CUP will also assign each payload to a particular transportation system (i.e., Shuttle or ELV). The Associate Administrator for Space Station Operations will sign the CUP (acting in his role as Chairman of the MCB), and sign all of the Requests for Flight (U.S. and international), thereby accepting all payloads into the program. He will then forward the CUP to the UOIO for implementation.

At this point, all users on the CUP will have received a commitment to fly on the Space Station and to a calendar quarter, although they will not have received a commitment to a specific date.

## Initial Assessment and Development Planning

When the CUP is released, the user will initiate payload development activity and will become a member of the Space Station Users Working Group (SSUWG), which will represent the interests of all the users in the program.

At the same time, the User Accommodations Integration Office will assign the user a Payload Accommodation Manager (PAM), who will assist the user in completing all SSP assessments and documentation, and in meeting the requirements imposed by the Program and by the transportation system that will carry his payload. The PAM will work with the user to develop a Payload Integration Plan (PIP) and annexes specifying the user's requirements and responsibilities for all phases of the program. The PAM will be the user's single point of contact with the Space Station Program, as well as with the transportation and data systems offices, for the remainder of his participation in the program with this payload. Although the user will be required to satisfy the requirements of many offices within the Program and will be at liberty to contact these other offices if he so desires, he may direct all his inquiries through the PAM. Similarly, all requests from the SSP to the user will be routed through the PAM.[68] This arrangement will minimize the confusion that would be caused by multiple user-program interfaces.

The PAM's first responsibility will be to arrange for an indoctrination meeting which will outline SSP requirements and reviews. He will also work with the user and the sponsor to assemble a development plan for the user's payload and the associated operations procedures and ground facilities. The PAM will monitor the user's payload development to ensure compliance with standards and with schedules.

The user's sponsor may also assign an experiment development engineer (possibly from an S&T Center) to assist the investigator in designing and developing his payload. In this case, the PAM would work with both the user and his engineer. Thus, the S&T Center, other sponsor organizations, the Payload Operations Integration Center (POIC) and the PAM may all assist the user in developing his payload, operations plans and ground facilities. The extent of the support provided by the PAM and/or POIC personnel depends on the terms agreed to in the Request for Flight submitted at the beginning of the user's involvement with the Program.

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[64] *Formerly a Form 100.*

[65] *This commitment will be based on information provided to the sponsor by the OSSO User Operations Development Division. It is important that UODD provide the sponsor codes with sufficiently detailed documentation regarding operating costs and pricing policy to enable the sponsor to negotiate this commitment.*

[66] *If the sponsor's total payload complement exceeds that sponsor's allotment, the SSUB will send the complement back to the sponsor for the sponsor to pare down.*

[67] *The international partners will solicit and select users according to their own procedures. As with U.S. payloads, however, the proposed payloads will undergo a feasibility assessment by the UOIO prior to submission to the UOP.*

[68] *Initially, all PAMs will be drawn from the element development centers, and will have particular expertise in the characteristics of the element where the payload is to fly. In the future, the PAM assigned to the user may be drawn from the appropriate sponsoring organization or S&T Center so that he will have sufficient expertise in the relevant discipline to perform both the PAM and experiment development engineering roles (i.e., to support the user both in developing his payload and in satisfying SSP requirements). The UAIO would be responsible both for ensuring that an appropriate PAM is assigned, and for training and certifying the PAMs sponsored both by OSSO and other NASA-sponsored offices.*

**Integration of User's Requirements into TOP and Assignment to a Flight Increment**

Approximately 24 months before flight (typically at or near payload PDR), the user's payload will be entered into a specific flight increment within the Tactical Operations Plan. To do this, the user must define his Station requirements to the point where they can be coordinated with those of other users. The PAM will arrange for a series of reviews and briefings (including a safety review) with all of the institutional operations offices involved in supporting the user's payload.

The PAM will use the information obtained in this round of assessments to update the PIP and its Annexes. The Utilization and Operations Integration Office will combine the information in the user's PIP with requirements provided by other users, the Office of Space Station Operations, the Office of Space Flight, and the international partners to assign the payloads to a specific flight increment.[69] This new increment will be added to the Tactical Operations Plan (TOP) which covers all of the increments scheduled to occur over the next two years.[70] The TOP must be approved by all of the partners via the Program Operations Control Board (POCB), which is responsible for oversight of tactical operations planning.

A user must enter the SSP planning process by this stage if he requires a "complete" range of Station resources (particularly significant crew time and/or power). Because of planning constraints, users entering the increment after this point will be restricted with regard to the range of payloads they can implement. For instance, crew specialization and composition is determined soon after the release of the TOP, and crew user training begins at approximately 18 months before launch; as a result, major new crew operations cannot be added to the operations plans once the crew has been assigned.

The TOP will provide "top" level data pertaining to the integration of payload and key Station operations requirements over the course of the increment. Space transportation systems and data systems support operations will also be included. Once his payload is included in an approved TOP, the user becomes involved in utilization planning for that increment. A Program-provided Increment Change Manager is assigned to lead in development of a Flight Increment Plan (FIP), which integrates payload and space systems operations requirements down to the next level of detail. The FIP identifies specific scheduling constraints, crew skills and work load, payload objective priorities, and specific maintenance and servicing requirements in order to provide the execute planning teams with the data they need to develop implementation-level plans and procedures. The Increment Change Manager is support by an Increment Management Team, composed of representatives of operations organizations and of the PAMs who represent the increment users. The FIP is refined over a period of about six months, and is baselined approximately one year prior to the beginning of the increment.

Based on the TOP and FIP data for an increment, the System Engineering and Integration Office (SE&IO), working closely with the assigned PAMs, will support the increment users by serving as Program liaison with the transportation and data systems services organizations regarding the integration and accommodation of user requirements for transportation to and from the Station, and for payload data handling. In this capacity, the SE&IO will represent user requirements in planning meetings, process required Program interface documentation, develop associated TDRSS utilization plans, and coordination of up/down manifests implementation.

The TOP, FIP and related transportation and data systems services integration plans and manifests will then be forwarded to the various operations support centers where increment execute planning will begin. Similarly, the transportation and data systems services organizations use the documentation to affect their own detailed planning. Additionally, the NASA Safety, Reliability, Maintainability and Quality Assurance Office will review matters of safety, particularly the payload operation issues reflected in the Increment Hazard Control Plan -- a product of the increment execute planning process.

Once the user has been assigned to a particular flight increment, he joins other PIs for that increment in an Investigators Working Group (IWG), which will be directed by an Increment Scientist. This group will work together to support development of the FIP, and to participate in operations execution planning based on the contents of the TOP. The IWG will consist of representatives from each user (or at a minimum, from each discipline operations center and each direct user). It is anticipated that many of these coordination activities will, in practice, be handled by the IWG's Increment Scientist, PAM or other user representative on behalf of his users.

**Payload, Operations and Ground Facility Development**

In addition to developing his payload, the user needs to gain access to ground facilities from which to monitor and operate his payload as needed during flight. These facilities must provide all capabilities necessary to allow the user to perform any required teleoperations, and to oversee any relevant crew activity. The user also will be responsible for training any necessary staff to operate the payload from this facility, based on the payload's operations plan and characteristics.

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[69] *The UOIO also uses this information to update the Mission Requirements Data Base (MRDB).*

[70] *This TOP is based on a 45-day STS revisit schedule.*

It is anticipated that most users will be assigned to a Discipline Operations Center (DOC) or Regional Operations Center (ROC) by their sponsor or S&T Center. DOCs will be facilities established to support work in a single discipline; ROCs will support users in a specific geographical area. The DOC or ROC will coordinate the operations of its members during flight preparation and execution, and may make operations facilities available to the users. If desired, the user may build his own User Operations Facility (UOF) that will link up with the Station and be coordinated with other users via the DOC or ROC. Users who operate their payloads in or via a DOC will be referred to as "discipline users," while ROC users will be referred to as "regional users." Some users (particularly commercial proprietary users) may develop independent UOFs that interact with the Station directly via the POIC; these users will be called "direct users."

### Final Operations Assessments

About 18 months prior to launch, the Increment Change Manager coordinates final operations assessments by the SSSC, the POIC, and all other offices involved in accommodating the payload. The user's PAM and sponsor organization support this assessment as required. Based on all of the user's operations assessments and the initial planning efforts of all OSSO offices, an increment flight crew is assigned at this time.

### Integration of the User's On-Board Operations into the Execution/Operations Planning Process

Based on the FIP and on the results of his final operations assessment, the user will participate in the increment execute planning process. These execute plans are refined continuously until the Increment Operations Plan (IOP) and supporting procedures and data are finalized six weeks prior to the launch that initiates the flight increment; changes occurring after this time are considered a part of the "replanning" process which continues throughout the increment.

To initiate the execute planning process, the SSSC will update the resource envelope available to users, based on the TOP, FIP and updated systems requirements estimates, and will forward this estimate to the POIC. The POIC will adjust the resource assignments to the various DOCs, ROCs and direct users, who will develop refined and updated operations plans. The POIC then develops an integrated user operations execution plan. After approval by the IWG, this user operations execution plan is passed to the SSSC for verification of compatibility with Station systems requirements and for publication as part of a Preliminary Increment Operations Plan. If there are any conflicts between user requirements that cannot be resolved by the IWG, the POIC has the authority to resolve them. If there are conflicts between user and systems requirements, the SSSC will be responsible for resolving them. Any disputes that cannot be resolved within the SSSC/POIC must be taken to the POCB.

This process will result in a plan which assigns the user a particular envelope of resources (crew time, transmission time, power, etc.) within which he is free to carry out his operations. If the user requires intermittent contact with his payload, he will be assigned particular blocks of time within which he can contact his payload. If he requires contact with the astronauts, he will be given access to a voice link as necessary. He can then plan his DOC, ROC or UOF activities within this envelope.

### Crew Training Requirements

The user is responsible for training the Station crew and ground personnel in the operation and maintenance of his payload. The user will explain to the Station crew and ground personnel the scientific background of the payload and the experiment objectives, familiarize the crew and ground personnel with the experiment systems, and teach the crew the operations plan for his payload. These activities will occur at the PI's site where he can draw on his own facilities in training the crew and ground personnel. If the user will be providing a Payload Scientist, this person will be instrumental in this training function.

Following these sessions at the user's facility, users with particularly complex payload execution requirements will be asked to deliver two high-fidelity copies of their payload and any related software to the SSP for use in simulation and training activities. These models would "migrate" as needed through the simulators. They would be used first at the high-fidelity simulator collocated with the POIC, then move to the SSSC/SSTF as the crew moves from integrated payload training to integrated increment training.

The user would also undergo training provided by the SSP, in concert with the crew and other users. This training would familiarize the user with the command procedures for normal and contingency situations, teach him about the "transaction management" system used to ensure that user operations do not conflict with one another, and verify that his UOF is operational prior to launch. If a Payload Scientist will operate the payload on the Station, this individual must be trained in Station habitation, health maintenance, and in operating other crew systems (such as cameras, communications systems, etc.).

### Payload Integration and Logistics Operations

Prior to launch, the user's payload must be integrated into experiment racks or other carriers, and the racks into one of the SSP logistics modules or external pallets (U.S. or Japanese). Payloads may be integrated into racks either at the S&T Center which has supported the user, at the launch site by the U.S. Pre and Postflight Operations Office, or at integration facilities provided by the international partners in the U.S. or abroad. The location of rack integration depends both on the terms of the PIP agreement, which sets out the user's relationship with an S&T Center; and on the location of the payload on the Station. (Payloads flying on international elements are integrated by the international partners.)

If the user will be sending any supplies or spares along with his payload (or on a later increment, if the experiment continues), he will coordinate provision of these ancillary materials through the PAM to the Logistics Operations Office for incorporation into a logistics module.

The Logistics Operations Office will make storage and preservation facilities at the launch site available to the user according to terms established in the PIP agreement. These facilities will support users from the time the payloads are delivered to the launch site until launch.

### Prelaunch Processing

Once the racks and other equipment have been integrated into the logistics module or pallet, the Space Station Program delivers the module and any other carriers to the Office of Space Flight. OSF integrates the module into the Shuttle or other launch vehicle, and is responsible for the module from that time until it has been off-loaded onto the Station. If the user requires late access to his payload after integration into the Shuttle or ELV (for feeding of laboratory specimens, handling of perishable substances, or last-minute loading of experiments), the SSP will arrange for that access via the PAM. All late access requirements will be coordinated by the SSP SE&I Office with the Office of Space Flight. OSF is responsible for overseeing and executing late access requirements to the STS and/or ELVs.

### On-Orbit Check-out/Verification

After the Shuttle has docked with the Station, and the logistics module has been unloaded, the Space Station crew will install the new racks and equipment. Once the user's payload is in place, it must undergo an on-orbit check-out to ensure that it is functioning properly. The order in which systems and payloads are checked out is determined prior to launch as part of the increment execution planning process. From his operations facility, the user will issue the commands required to complete checkout and verification, and will oversee the activities of the crew. The POIC will integrate the user's commands with those of any other user, and pass them on to the SSSC for relay to the Station. The crew will perform any necessary onboard adjustments as overseen by the user and the SSSC. If the user desires, the crew will perform the entire payload check-out procedure, freeing the user from the responsibility for issuing checkout commands or overseeing onboard activities. Once the payload and systems checkouts have been completed, increment operations can begin.

### Integration of User Operations in Daily Replanning Process

The Increment Operations Plan covers the entire period of increment operations. However, detailed crew integration planning is provided by the IOP only for the periods involving STS/ELV transfer operations or other activities requiring complex crew/ground interaction (e.g. OMV missions, complex EVAs). Planning for routine operations during the increment will be coordinated on a daily/weekly basis by the execute planning teams at the SSSC and POIC and forwarded to the onboard crew for implementation. Each day, the SSSC will update the POIC on the status of Station systems; the POIC will in turn update the IWG on the status of the user resource envelope. If there are any changes to this envelope, it is up to the IWG to coordinate changes to the individual user plans. (The IWG or representatives of the IWG will be located at the POIC during the operations increment to support this function.) Under the direction of the Increment Scientist, user representatives will negotiate new resource and time envelopes and forward a modified consolidated plan to the POIC; the POIC will in turn hand the consolidated plan over to the SSSC to check for compatibility with Station systems replanning data.

### Inflight Operations

While his payload is in orbit, the user must perform operations originating from his UOF, and oversee any actions taken by the Station crew with regard to his payload. He is also responsible for monitoring the status of his payload to ensure that it remains in safe operating mode. The POIC monitors Station support to all user operations to ensure compliance with user requirements. At the same time, the SSSC monitors systems status and ensures that user operations are not adversely affecting the safety or health of crew or Station.

The user will receive data from his payload while it is operating on orbit that will allow him to determine whether his payload is functioning as planned, or whether changes in hardware, specimens or plans are necessary. If changes are required, he can negotiate for additional crew time or other resources through the IWG as part of the daily replanning process.

If the user's instrument suffers a failure during flight, it is his responsibility to correct or coordinate correction of that failure unless the Station systems are suspected of causing the failure. The user may develop a payload inflight servicing plan prior to flight which must be performed by the crew. (This expense must be covered by the user.) Any changes in the user's operations (such as contingency operations) must be approved within the IWG and by the POIC/SSSC prior to implementation.

### Updating Requirements for Continuing Operations

If the user's payload will operate for more than one increment, the user must forward any changes in his resource requirements to the Utilization and Operations Integration Office for inclusion in the plan for the next increment. These changes must be approved by the POCB before the start of the next increment.

### Payload Shut-Down and Safing for Return

When the user's operations have ended and the payload is to be returned to earth, the user is responsible for turning off his payload to ensure safe rack deintegration and to protect his specimens or results. As for payload checkout, the Increment Execute Plan will include a schedule for this process. The user will perform any ground-based commands and oversee the actions of the crew in dismantling the equipment. The POIC will integrate all user requirements; the SSSC will integrate these user operations with the systems changes necessary during an increment handover.

### Payload Pick-Up

Following the return of the payload to the earth, the user must pick up his payload and his product and/or data. The Pre and Postflight Operations Office will deliver the rack (or racks) for deintegration to whatever organization integrated it prior to launch. The Logistics Operations Office will then deliver the payload to the customer using the means of transportation appropriate to the equipment. If the user requires, the SSP will allow him to retrieve the payload at the STS landing site. The timing, location and service fees associated with the pickup, as well as the means of transportation, will be negotiated as part of the original PIP agreement or a later amendment to this agreement.

### User Debriefing

When the user's operations for a given payload have been completed, he will undergo a debriefing involving his sponsor, his PAM, the Utilization and Operations Integration Office, the Pre and Postflight Operations Office and the Logistics Operations Office. This debriefing will be used by the SSP to improve its services or interfaces; by the user in planning for his next payload, if any; and by the sponsor in determining the utility of the Station in fulfilling its goals.

### Archiving of Data

Some users (particularly science, applications and technology users) will want or be required to archive data to make it available to other users within their disciplines. Unless otherwise negotiated as a part of the PIP, archiving of payload data will be handled by sponsor organizations -- the S&T Centers or the DOCs.

### III.D.2. Platform User Flows

The process by which a platform is developed, launched and operated is quite similar to that by which the core resources are distributed and utilized, although it is handled entirely separately. There are, however, some major differences. First, since the platforms will be sponsored, built and operated by the individual partners, most platform decisions will be taken by the sponsoring partner without requiring approval by the other partners. Only those activities which draw on common resources (e.g., servicing missions which utilize the manned base) will be subject to the review process outlined above.

Second, most of the organizational entities involved in handling platform operations will be independent of those responsible for the manned base. A Platform Support Center (PSC) will correspond to the Space Station Support Center (SSSC), and will also handle the relevant responsibilities of the Payload Operations Integration Center; these latter responsibilities will be much less extensive than those necessary to operate the core Station. Within the Utilization and Operations Development Division, the Utilization and Operations Integration Office, the User Accommodations Integration Office, and other relevant offices, a separate subdivision will exist to handle platform-related activities.

The following sections detail the process by which a new platform is developed, and the process by which new payloads are added to an existing platform. The text refers to Parts 2 and 3 of the detailed user scenario flowchart associated with this volume.

### Development of a New Platform

#### (1) Selection of Platforms and Payloads

In general, platforms will be discipline-oriented (i.e., developed to pursue a specific line of research). The sponsor (either a NASA office, another government agency such as NOAA, or a private sponsor) will develop a proposal for a platform, and discuss the requirements with the OSSO Utilization and Operations Planning Office. The OSSO will act as an agent, procuring common hardware elements from the relevant contractors. This arrangement will reduce the cost of the platform hardware to the sponsor, and will ensure compatibility with Station operating and servicing procedures, standards and hardware.

The sponsor must then obtain funding for both the platform hardware itself and for the individual payloads. The SSUB will review the platform proposal to ensure that it meets the goals of the U.S. user community. Once approved by the SSUB, the Office of Space Station Operations will assign a mission manager to oversee all activities relating to the platform.[71] The sponsor will release an Announcement of Opportunity (or otherwise solicit principal investigators), and select payloads for definition.

The Utilization and Operations Planning Office will assist the sponsor in performing feasibility and compatibility reviews -- ensuring that the payloads selected are compatible with the platform hardware and with each other. The relevant operations organizations will support these assessments. These reviews will allow the sponsor to select the users whose experiments will make up the initial complement of platform payloads.

Once the feasibility and compatibility assessments have been completed, the sponsor and the user must agree on the user's resource requirements, operating regime, date of launch, and priority. The Utilization and Operations Planning Office will assist in developing and negotiating the Request for Flight that lays out the terms under which the user's payload will fly. The SSUB will then review and approve the selected payloads and forward the list to the User Operations Panel for inclusion in the Consolidated Utilization Plan. At the same time, the Associate Administrator for Space Station Operations must sign off on the agreements, indicating his office's commitment to building and operating the platform, and to the schedule laid out.

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[71] *If desired, the sponsor can provide the mission manager*

(2) Payload and Procedures Development

Once approved by the sponsor and the Associate Administrator for Space Station, the user will begin to develop his payload and procedures. As discussed for the manned base users above, a Payload Accommodation Manager will be assigned from the Office of Space Station Operations' User Accommodations Integration Office. The user will develop his payload and complete a series of operations and design reviews. (The operations reviews are performed by the Space Station Operations office with support from the sponsor; the design reviews are performed by the sponsor with support from the SSP operations office.) The Payload Accommodation Manager is responsible for ensuring that all reviews, assessments and planning involving that payload's interaction with the platform. The Mission Manager coordinates all payload activities, conducts Operations Readiness Reviews, and coordinates development of the Increment Operations Plan and supporting procedures and data with the support of the PSC execute planning team. The sponsor ensures that the payload meets its own goals and requirements.

The Utilization and Operations Planning Office will negotiate a launch date and launch services agreement with the Office of Space Flight.

(3) Delivery of Payload Emulators/Simulators

Some months prior to launch (the exact time remains to be determined), the user will deliver payload emulators and simulators to the Integration, Test and Verification Facility (ITVF). The ITVF will integrate these hardware and software models for use in training the platform operations ground crew and for user training.

(4) Delivery and Integration of Payloads with Platforms

Some months before launch (time dependent upon payload complexity), the user will deliver the payload for integration into the platform. The platform may be integrated by the sponsor itself, or by the ITVF. The user will provide launch site support as necessary, monitored and assisted by the PAM. After integration, the Cargo Integration Group will perform final interface testing and loading, and prepare the platform for integration into the launch vehicle. The Office of Space Flight will then launch the platform.

During this period of time, the user will undergo training in platform/payload operations. The ITVF will oversee this training activity.

(5) On-Orbit Check-Out, Verification and Operations

Once the launch vehicle has placed the platform in orbit, the Platform Transfer Operations Center within the Platform Support Center will perform any orbital adjustments, system check-out and verification, and other activities required to bring the platform into working order. Then the users will perform payload check-out and verification, with the PSC providing interface coordination and control. Once all payloads and systems are up and running, the users will participate in replanning on an as-needed basis. The PSC will notify the users, via the Platform Investigators Working Group, of any changes in platform resources or capabilities. The Platform IWG will negotiate any disagreements, and develop a new user operations plan; the PSC will ensure that this plan is followed by the users.

## Addition of New Payloads to an Existing Platform

The sponsors may plan to change out some or all of the payloads for new ones after the platform has operated for a time. The sponsor must obtain approval for a change-out mission involving either the Space Shuttle or the Space Station.

(1) Development of a Change-Out Mission

Having planned for some payloads to be changed out, the sponsor must solicit and select new users via the process outlined above. The Mission Manager must then oversee the development of a consolidated mission plan for payload change-out. Since this mission will involve the manned base and its crew, the safety reviews, training and other operations and planning elements for manned base operations must be involved in developing the mission plan.

(2) Approval by the MCB

Because the change-out mission will involve SSP resources that are under the purview of all the partners, the mission must be reviewed according to the multilateral process outlined for manned base users. Once the SSUB has approved the consolidated change-out mission, the proposal will be forwarded to the UOP for inclusion in the CUP and approval by the MCB. It will follow the same strategic and tactical planning process followed by all manned base users.

(3) Payload and Procedure Development

The development of the user's payload and procedures will occur in the same manner outlined in the New Platform scenario, except that he will have to be compatible with the platform operations environment and either the manned base or STS operations environment. The user's PAM will be his agent for interactions with both organizations as required, and will ensure that differences in organizational protocol are as transparent to the user as possible.

The Platform IWG will work with the PSC as described above to develop a platform operations plan. The PIWG will also work with the POIC and SSSC to develop plans for check-out and verification activities at the manned base before the platform is returned to its operational orbit. The Platform IWG will represent all platform change-out users on the Increment Working Group overseeing the manned base operations during the increment when the change-out will occur. This participation will ensure that platform requirements for crew operations, checkout and verification and other manned base operations are met.

The user will deliver hardware and software payload simulators to the Space Station Training Integration Group for use in crew training (for the physical change-out of the payload), ground crew training (for operation of the platform), and user training. Training will occur as described above.

The user will deliver his payload either to the sponsor via an S&T Center, where it will be integrated into special carriers or other equipment, or directly to the Cargo Integration Office for integration into the logistics module or other carrier. He will provide launch site support as necessary.

(4) On-Orbit Operations

At some point prior to the payload launch, the Platform Transfer Operations Center will maneuver the platform in for docking with the Station. When the platform is operated within the vicinity of the manned base (i.e., for servicing missions), the PSC will work under the direction of the SSSC to ensure the safety of the manned base and crew.

Once the payloads and the platform are at the Station, the crew will perform the change-out. This may occur while the Shuttle is still docked with the Station so that the payloads being removed can be returned to earth with the Shuttle. The user will monitor this activity, if necessary, from his own facilities or from facilities at the S&T Center or elsewhere. If desired, the user can perform check-out and verification procedures to ensure that the payload is in operating order, prior to the platform's release from the Station. The POIC and SSSC will provide interface coordination and control, as described in Section III.

Finally, the platform will be returned to its operational orbit; the Platform Transfer Operations Center in the PSC will work with the SSSC to perform these maneuvers and reestablish the platform in its specified orbit. Regular operations will then begin as described above.

# IV. SPECIAL TOPICS

The Task Force, in conducting its review of Space Station operations, recognized that there were a number of issues of importance which were not a direct focus of the Framework, but which would affect the ability of the operations organization to meet Program goals. This section provides brief summaries of these issues:

a. Program Observations
b. Program Operations Costs
c. International Issues
d. Proprietary User Operations
e. Station/STS Operations Synergy
f. Safety
g. Station Pricing Policy
h. Crew Training
i. Space Station Information System (SSIS)
j. Space Station Management Information System

## IV.A. PROGRAM OBSERVATIONS

The SSOTF effort took the CETF baseline Space Station configuration largely as a "given"; however, as part of its charter the SSOTF was asked to evaluate the adequacy of that baseline to meet user and system requirements. In its analysis, the SSOTF identified several potential trouble spots in the baseline architecture. These deficiencies could reduce operational flexibility; hence, the Task Force includes the following Program observations and design considerations for further Program review.

### Other Space Launch Vehicles

Current planning for Station operations assumes that there will be eight STS flights per year dedicated to Space Station support (manned base and platforms). The Phase B definition studies of Station up/down mass and crew transfer requirements indicated that this is a minimum requirement. Projected upweight transport requirements are beyond the capacity of the Shuttle bay, and suggest that expanded operations would not be possible unless a higher percentage of STS flights could be devoted to the Station, Shuttle upgrades were implemented which materially enhanced the carrying capacity of the fleet, additional orbiters are added to the fleet[1], or use of ELVs is considered.

The likelihood of devoting a higher percentage of existing capability to the Station was dismissed because of the continuing requirements to use the Shuttle for other high priority government missions. In fact, it appears likely that the Station will have fewer STS flights available. NASA's joint Space Flight/Space Transportation Study, performed separately from the SSOTF effort, has examined whether it is possible to reduce the number of dedicated STS flights to five or less.[2]

The major vulnerability of lower STS support projections is in payload transfer, rather than crew transfer. (With five or more STS flights per year crew support capability is not affected.) For example, by extending crew stay times from 90 to 120 days and increment periods from 45 to 60 days, STS Space Station flights can be cut from eight per year to six.[3] However, the cost, in terms of user operations, would be severe. Over 100,000 lbs. of transport capacity would be lost, and most of this would be absorbed by user payloads. (Supplies to support and maintain the crew and Station systems can be likened to fixed costs, and are relatively insensitive to STS flight rate.)

The Task Force suggests that NASA utilize expendable launch vehicles to the fullest extent feasible for both the Development and Mature Operations Phases of the Program. Specifically, the SSOTF judged that ELVs could be used for launch of the polar orbiting platform, and for logistics supply to the Station. Addition of ELVs would allow the STS/Station interface to be maximized for crew-related transfer and the launch and return of high-value payloads. The Task Force did not recommend the use of a specific ELV; it was acknowledged that the Program should be able to draw on any available vehicle, including a "heavy lift" vehicle, as logistics and payload transport needs dictate.

The Task Force also recognized partner interest in development of new manned space transportation vehicles. The Task Force believes that these vehicles could provide a valuable augmentation of Space Station logistics capability (especially for crew transfer), but noted that it should be incumbent upon the developers of new manned systems to make them compatible with the Space Station, rather than the reverse.

### Downweight Limitations

The Space Station Program currently baselines the use of the STS for the return of all materials from the manned base to the Earth. With eight flights per year, the STS appears incapable of accomplishing this task, even after subtracting the mass of consumables (such as air and water) which can be vented overboard.[4]

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[1] *Provision of additional orbiters, given existing budget constraints, was not pursued as an option available to the SSOTF.*

[2] *This analysis projects that even with a 10,000 lb capacity augmentation and the exclusion of the orbiter Columbia from the Space Station support role (Columbia's payload capacity is 7,200 lbs. less than the newer orbiters), a minimum of six flights per year is required to meet payload mass transport requirements.*

[3] *NASA's manned spaceflight experience base allows for crew staytimes of up to 135 days (projected from Skylab experience by the life sciences experts). Assuming an eight man crew, and the ability to "change out" four crew members per mission, the minimum STS requirement is 5.4 flights per year. At lower flight rates, either entire crews must be changed out (which suggests a change to single shift crew operations with a maximum Station crew size determined by maximum STS passenger capacity), or partial crews must be changed out which counters the SSOTF recommendation that crew teams train and work as a unit. It is assumed that maximum staytime on orbit will increase as experience in long duration flight grows. A 180-day staytime would allow crew team changeout with only four flights per year.*

The SSOTF believes that it is inefficient for the STS to ferry back "garbage" from the Space Station. One potential solution for this problem is the development of lightweight, low-cost disposable canister or packaging system for deorbiting non-toxic materials from the Station. The canister would burn up upon controlled reentry;[5] the STS capability would then be reserved for the return of crew and high-value products and equipment.

### Emergency Crew Return

One of the key design and operational issues for the Space Station Program is crew safety. The reference configuration provides a 28-day "safe haven" capability in the event of a major onboard failure (e.g., depressurization of the habitation module). This period was determined at a time when planners expected the four orbiter fleet would be capable of 24 flights per year. It was judged that four weeks would be sufficient time to "scramble" a rescue mission.

The Challenger tragedy illustrates the risk in relying solely on the orbiter fleet for emergency return capability. A catastrophic accident may ground the fleet for years; less severe anomalies could result in downtimes of several months. Should the Space Station crew be reliant upon the STS for emergency return, NASA would face the decision to launch a rescue mission with a high risk of failure.

The SSOTF's analysis of on-orbit crew health also indicates the need for a more rapid return capability in the event of major illness or injury to one or more crew members.[6] Using the Soviet long-duration flight experience as a proxy, the Program can expect problems requiring rapid crew return to Earth to occur every 1-2 years (assuming an eight man crew). Even if a Shuttle flight could be launched within 28 days, it might not be soon enough to save the afflicted crew members.

For both of these reasons, the Task Force recommends that NASA more fully incorporate emergency crew return concepts into current Phase C activities. (See Section V for complete recommendations.) The SSOTF did not conduct a full analysis of emergency return requirements; however, a few parameters were defined. First, the vehicle should not require extensive crew operation, as the Space Station crew members will not possess the same type of pilot's skills as STS pilots and commanders have. Second, the vehicle should have a low-G re-entry profile (3G max.) consistent with transport of an injured or ill crew member. Finally, the emergency crew return capability should incorporate basic medical stabilization capabilities (intravenous, electrocardiographic).

### Onboard Environment

The goal of environmental monitoring (EM) is to quantify and track all potential biological hazards. The EM system must be capable of measuring volatile substances (organic and inorganic), particulate matter, and the microbial load of the manned base atmosphere.

The manned base EM requirements are significantly more extensive than those for the STS. Manned base mission duration precludes the assessment and certification of the internal environment by post mission analysis of samples obtained in flight. Experimental activities such as materials processing, combined with the inability to return the manned base to earth for complete cleaning between missions, and the effects of "tight building syndrome" require EM to be performed continuously on the manned base.

Onboard contamination without sophisticated capabilities to rapidly monitor, identify, quantify, contain and control toxic substances could force immediate or eventual evacuation. The Space Station Program should immediately initiate and support a vigorous EM project which incorporates a materials safety identification and review process, an EM monitoring system, procedures design to prevent or minimize materials interaction problems, development of procedures and equipment necessary to contain a toxic hazard, and development of procedures, equipment, and non-toxic cleansers and disinfectants for routine maintenance and periodic cleaning of the manned base.

### Interoperability of Ground Systems

The SSOTF notes the need to provide for interoperability of critical functions within the Program's command and control ground facilities. The majority of the ground network support facilities are not currently planned to be redundant. For example, the SSSC might be capable of supporting platform operations if there is a major failure at the PSC or vice versa. The Task Force suggests that there should be no single point failure nodes allowed in the design of the command and control network for any of the space elements, and further notes that the proper time and place to build in interoperability is from the beginning, and through marginal upgrades of baseline ground support facilities. At a minimum, there should be a redundant capability for basic manned base system support: the PSC and POIC (separately, or in combination) must be capable of supporting manned base housekeeping requirements in the event that the SSSC is rendered inoperable.

### Loss of Critical Element

The Program baseline includes only one copy of each major manned base hardware element. The Task Force notes that there is no recovery plan for loss of a critical element, nor is there yet detailed consideration of spares requirements or policy. Task Force Members knowledgeable about the STS spares program note that lack of a coherent policy for spares buildup and inventory has resulted in higher operations costs for the STS program, and that it should not be allowed to recur in the Space Station Program. The SSOTF suggests that spares and replacement policy and directives should become integral to Phase C design and later operations and considerations.

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[4] *While the STS can carry approximately 32,000 lbs. of payload on Station support flights, the orbiter's payload landing capacity is only 25,000 lbs. This figure is inclusive of the mass of the logistics module or any other flight support equipment.*

[5] *The Soviet Progress expendable launch vehicle already incorporates this capability.*

[6] *Such illnesses include relatively "common" problems such as appendicitis, gall stones, kidney stones and ulcers. Unfortunately, the empirical database for predicting medical risk is incomplete, and "close analogies" (e.g., experience on submarines) are not fully transferable to the Space Station.*

### Polar Platform Servicing

The availability and capability of the STS to support polar orbit missions remains a source of concern. As noted above, the Office of Space Flight and Office of Space Station are examining ways in which the Program's dependence on the STS can be reduced to 4-5 flights per year. The Task Force recommends launch of the polar platform using an ELV as a means of conserving valuable STS capability and enhancing platform performance. (See Section V.)

Task Force members also remain concerned over the ability of the STS to perform polar orbit servicing missions. First, there is uncertainty as to the availability of the VAFB SLC-6 launch site. Secondly, the Task Force questioned whether the cost of polar orbit servicing missions, when combined with the lowered STS payload capacity, warranted development of a serviceable polar platform. The SSOTF suggests that the Program reconsider polar platform design, to see whether planned missions can be more efficiently conducted using "throwaway" platforms launched by ELVs.

### Commonality

The Task Force noted that commonality in Station design and operations procedures among elements will significantly improve the safety of on-orbit operations, and can generate significant cost savings as well. At present, commonality in element hardware is not a requirement, and some would prefer that the partners retain freedom to develop their own components and sub-assemblies, consistent with agreed-upon reliability standards.

SSOTF members noted that there were several means of ensuring that such commonality preserve the industrial perogatives of the partners. For example, common hardware components could be allocated on a partner basis in proportion to the partner's total contribution to the Phase C effort. This implies that the U.S. modules would incorporate some foreign-built hardware, and that U.S. hardware would be incorporated into the foreign modules. Alternatively, common component designs could be licensed among contractors within each partner's jurisdiction. This would have the additional benefit of ensuring multiple sources of supply, but may result in higher costs per unit.

### Space Network Support

Although there have been past studies pertaining to the closing of the Zone of Exclusion (ZOE) wherein communications with the ground are lost, the SSOTF suggests that new trade-off studies should be done to determine the costs and benefits of providing continuous "acquisition of signal" (AOS) during manned base operations. This would prevent routine data loss or interruption due to such things as TDRS handovers and ground station ZOE periods. This suggestion is based on experience and lessons learned from Skylab, Spacelab, and STS payload missions where the crew members' premium time was spent tending onboard tape recorders, and ground personnel time was spent developing recording timelines and supporting level-zero processing functions because of ZOE-induced onboard tape recorder playbacks.

It is extremely important to provide the potential for continuous AOS in order to meet anticipated user requirements for the conduct of unencumbered telescience operations during the Mature Operations Phase. The trade studies should develop alternative approaches and assess the impact of Space Network assets. Alternatives should include the potential availability of International Space Networks and of U.S. commercially available capabilities.

### Logistics Planning

The provision of logistics support and design acquisition engineering inputs to the operational Space Station represents one of the major cost drivers of the Program, and is the most sensitive to the adequacy of design considerations given during the Phase C/D activities. The logistics subpanel addressed the spectrum of logistics issues from design to mature operations and across all Program elements, including the institutional support elements necessary for the thirty-year life of the Program.

The subpanel strongly supports the creation of an Integrated Logistics System which coordinates planning for system and user logistics, inventory, warehousing, and user payload verification and testing.[7] The Task Force was concerned with the lack of commonality in the ILS approach and specification in the Phase C RFPs for NASA elements. Hence, the SSOTF sees a need for the immediate establishment of a logistics planning function at the Program Integration Level in the transition organization to oversee the development of all logistics activities.

### Crew Health Maintenance

The manned base in-flight health care delivery system must incorporate the triad of modern medicine: prevention, diagnosis, and therapy. These functions must be performed with the capabilities of the Health Maintenance Facility. Given the presence of basic preventative, diagnostic and therapeutic equipment, the effectiveness of the in flight medical system is greatly dependent on the level of onboard medical expertise. The advantages of a crew member who can perform "routine" medical diagnosis and treatment are obvious. For a crew size of eight, at least two crew members should have a minimum of emergency medical technical training.

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[7] *In fact, an integrated logistics system is a logical follow-on to the integrated operations and utilization concept of the Recommended Framework.*

## IV.B. PROGRAM OPERATIONS COSTS

In past space systems programs, the relative magnitude of development costs have overwhelmed operations costs in calculating total program costs. However, over the long lifespan foreseen for the Space Station, operations costs will play a much greater role in determining the Program's total life-cycle cost (LCC) (combined development and operations costs). Over the time horizon envisioned for Space Station, operations costs represent more than half of the LCC, even when those costs are discounted over time.

### Program Cost Impact

The Task Force considered cost as one of several major factors in selecting operations concepts, but did not conduct a separate "bottom-up" cost assessment. The Task Force reviewed the recently submitted Space Station costs estimates for baseline Station operations and estimated the relative cost impact for each major new or enhanced facility or function required to support the Recommended Framework. In addition, the Task Force identified facilities and elements that were already identified in the baseline program, but which were inadvertently omitted from earlier development and operations cost exercises.

### New or Enhanced Capabilities

- Payload Operations Integration Center: The Recommended Framework requires a Payload Operations Integration Center (POIC) to consolidate and manage user operations for the manned base. The POIC will require significant data management, communications and operations capability. The Task Force determined that the POIC should be located at Marshall Space Flight Center, separate from the SSSC.

- Medium Fidelity Lab and Hab Simulators: The addition of the POIC and its user integration responsibilities along with the anticipated increment crew training loading will require additional training facilities. These will include an additional medium fidelity habitation module and node simulator at MSFC and an additional medium fidelity U.S. lab module simulator at JSC. As well, both MSFC and JSC will require partner-funded medium fidelity ESA and NASDA lab module simulators.

- Payload Engineering Support: The Task Force concluded that user/payload integration engineering requirements have been underestimated; the scope of responsibilities identified by the SSOTF will significantly increase currently estimated manpower requirements. This additional support was assumed by the Task Force to be supplied using existing Center facilities.

- Master Integration Facility at Launch Site: The Task Force recognized that the international partners will require facilities at the launch site to carry out pre-launch and post-launch processing of logistics carriers for their elements. This Master Integration Facility will require modifications to the Space Station Processing Facility.

- Increment Change Management: The SSOTF concluded that increment management responsibilities were relatively undefined and substantially underscoped, and concluded that a separate increment change management office would be required.

- Upgrade of Baseline Communications and Tracking Capability: The Task Force concluded that Station operations would require increased capacity in the communications and tracking system (particularly the TDRSS or its replacement), including the development of S-band data communications capabilities and expansion of planned Ku-band capability.

- Logistics Module Design Modification: The Task Force determined that the logistics module design should be modified and access to the Shuttle launch facilities should be reviewed with the Office of Space Flight to permit late/early access to perishable supplies or experiments, or to tend living specimens while on the launch pad consistent with STS safety policy.

- Hardware and Systems Commonality with Internationals: The Task Force suggests that the U.S. and the International partners design hardware and software systems to permit the greatest possible commonality in order to increase efficiency and safety in onboard operations.

- Environmental Monitoring System: The Task Force suggests the addition of an environmental monitoring system to support safe crew operations.

- Additional Payload Racks: Additional payload racks will be required to permit rack/payload integration to be distributed to user-sponsor facilities to support decentralized payload/rack integration.

### Facilities/Capabilities Underscoped in Baseline Requirements

The following resources will be required regardless of the operations framework selected; they were identified by the Task Force as missing from previous studies.

- New Logistics Information System: The existing KSC Inventory Management System (KIMS) will not be capable of supporting the volume of information involved in Station operations. Thus the Program must augment KIMS for the inventory management function and develop a new Logistics Information System (LIS). The LIS should be broader in scope than KIMS, encompassing maintenance and repair management, storage and retrieval of logistics support analysis data, and resupply/repair management.

- New Logistics Warehouse: Station supplies and logistics carriers in combination with the depot maintenance and repair function will generate a sufficient volume of materials and operations that they will require a new logistics warehouse to house them.
- Underscope of Logistics Support Requirements: In addition to identifying the above facilities requirements, the Task Force concluded that the scope of maintenance and repair requirements has been underscoped, and will require significantly greater manpower than previously estimated.
- Station/Platform Compatibility with ELVs: The Task Force reemphasizes the CETF recommendation that Station elements and platforms be compatible with ELVs to permit flexibility and robustness in launch capability.
- Hooks and Scars for Evolution: The Task Force reemphasizes past recommendations for hooks and scars to permit evolutionary upgrades to Station systems to support increased autonomy and operations efficiency.

## Operations Cost Management Process

In examining the issue of Space Station Program costs, the Task Force concluded that these costs can be managed effectively only if they can be confidently estimated. While the effort required to build the methods and models for such estimates may be high the potential payoff to the SSP is significantly higher. Thus, the Task Force concluded that the Space Station Program should adopt an annual operations cost estimating process which accounts for all major activities required for Space Station operations. This process should support:

- Life-cycle cost estimating and related incentives evaluations essential to the Phase C/D engineering design-to-cost efforts;
- Overall performance/cost tradeoff assessment studies needed to provide guidance in system evolution and operations procedures development;
- Performing operations risk assessments as they relate to life cycle costs;
- Evaluating contractor estimates;
- International cost sharing formulation and exchange rate/media determination;
- Program and related pricing strategies;
- Performance of operations cost risk assessments;
- Evaluation of contractor estimates;
- Annual budget preparation

The process should be formalized and cover all significant aspects of the Program. To facilitate such a process the Program should establish a logical consistency between the Program Work Breakdown Structure (WBS) and the Unique Project Number (UPN). The process should be tightly integrated with the Program's Operations Performance Assessment efforts.

### Purpose of an Operations Cost Model

As a first effort, the Program should consider formalizing development of an operations cost model as a major component of its operations cost management efforts. An operations costs model will serve several purposes during both the Development and Mature Operations phases of the Space Station Program. First and foremost, the model can provide a systematic method for assessing trade-offs between program design and operations decisions on the one hand, and the operations cost portion of LCC on the other.

The development of an integrated cost model provides an important alternative to conducting a series of grass roots cost exercises in response to "what if" questions. The consistency in assumptions and methodology enforced through the use of a model allows more reliable analysis of the results, since it eliminates any variances caused by individual perspectives or biases. A well-constructed cost model guarantees reproducibility of results, ensuring that any differences in cost projections result from different assumptions, not from the biases of the user.

Grass roots operations cost exercises do have value. However, they may provide a way of validating an operations cost model (or its parameters), and they may provide the operations cost modeler with special insights into the true sources of costs since the data is usually generated by personnel actually performing the operations tasks and is often empirical rather than theoretical in nature.

### Characteristics of a Useful Model

There are a number of very desirable characteristics that determine the long-term utility of any quantitative models. These include: (1) Responsiveness, the power to accommodate assessment of differing options; (2) Multiple Use Capability, the ability to address a number of operations costs issues and support a variety of applications; (3) Transparency, the supporting data and algorithms of the model should be easily accessible to the user; (4) User Friendliness, the ease with which the model can be manipulated by users with a minimum of training; and (5) Ease of Model Upgrades, the ease with which the model can incorporate data and algorithm updates as new experience develops new data and evolutionary trends change the basic assumptions of the model.

### Recommended Operations Cost Model

To save upfront model development costs, the Task Force reviewed a number of existing cost models for applicability to Space Station Program operating costs. Based on its review of the available models, the Task Force concluded that the JPL MESSOC (Model for

Estimating Space Station Operations Costs) model should be adopted as a high-level Space Station operations cost model. MESSOC is an "activity-driven" model which asks the user what activities are programmed for each year. Activities may be classed as mission/payloads, transportation, and ground support. MESSOC then calculates what those activities cost, and what resources remain for additional activities.

Once development is completed MESSOC appears most likely to meet the full range of requirements set out in this chapter. This recommendation, however, should not preclude the use of other contractor-developed operations cost models and programs for specific studies.

### Partner Cost Sharing Issues

A final issue with regard to operations costs is the basis on which these costs are distributed among the international partners. There are a number of ways to share these costs, including: (1) pooling all functions and basing each Partner's responsibility for the cost on its share of the utilization resources: (2) distributing responsibility to the partners both for individual functions and for their associated costs: (3) assigning each partner responsibility for the cost of functions associated with specific pieces of hardware; and (4) combinations of the above options. Any of these approaches might be negotiated among the partners, but each would have different implications for cost and management efficiency.

As a general principle, it is desirable that each partner benefits from the partnership in proportion to what it contributes to it. Inversely, each partner wishes to avoid sharing in any operations cost inefficiencies introduced by any of the other partners. Furthermore, the cost distribution and management structure should minimize, or at least avoid increasing, the total cost of operating the Station.

The actual method for distributing operations costs will be determined at the negotiating table. However, the Task Force made several observations as to the impact of these options on Station operations. First, as a general rule, it is desirable to have the partner who designs and builds a piece of equipment be responsible for the costs specific to that equipment as well. This arrangement establishes a strong incentive to develop hardware systems which are life-cycle cost effective. The U.S., which will provide a majority of the operating funds, has a very important stake in establishing the proper operating cost incentives.

A second issue in international cost sharing relates to the potential for U.S. subsidization of international operations resulting from the integrated operations concept. Because of the increased interconnectivity between operations by the individual partners, it may be more difficult to separate out the costs incurred by each partner's activities. As a result, it may not be possible to allocate accurately the overhead costs based on usage, and the U.S. may take up more than its share of these costs. However, this effective subsidization may be accepted as the price of reducing the overall costs of operating the Station and enhancing the safety of Station and crew. The effect may be minimized by improving systems for tracking actual use and estimating each partner's share.

## IV.C. INTERNATIONAL ISSUES

The SSOTF assumed that the foreign partners will participate extensively in all aspects of the Space Station Program, and endeavored to recognize the partners' requirements and desires wherever possible. The Task Force believes that the recommended framework of Integrated Operations will support international cooperation and provide for all envisioned partner activities in the Program. However, the Task Force recognizes that the partners would prefer to retain more responsibility for operations of the hardware elements which they contribute to the manned base. (Separate control of unmanned platforms is already a feature of the recommended framework.)

In addition to the recommended Integrated Operations framework, the Task Force evaluated a Partner Element Operations framework as an option. This section provides a brief description of this option, and compares it with the recommended framework.

In the partner Element Operations approach, each of the participating partners maintains and operates its respective flight elements on the manned base (similar to the platforms operations approach). NASA would retain overall management responsibility for planning and managing the manned base, but Program Integration and Program Execution Level functions would be carried out on a partner/element basis.

Top level policies for resource allocation and systems evolution would be accomplished through international negotiation (as in the recommended framework). Resources would be allocated to elements and then to user categories (demographic or disciplinary). Manifesting would be performed separately for each element, presumably at geographically dispersed sites and then coordinated among elements. Payload integration would be performed by the participants at their respective integration facilities.

NASA would retain responsibility for space transportation manifesting. Operational integration of systems and payload activities would perform duties in their respective elements. Operations support for both Station systems and users would be conducted at separate element support facilities, although the NASA SSSC would retain overall responsibility for manned base integrity and crew safety. Systems evolution would be performed at each element's ESC (as in the recommended framework), but configuration control and SE&I functions would be the responsibility of the element systems support center.

A comparison of the Partner Element Operations option, with the Integrated Operations option contained in the recommended framework, is presented in Table IV-1, and summarized below.

### Program Control

The SSOTF concluded that an operations framework based on Partner Element Operations could be managed, but that it would present a substantially

| OPTIONS<br>CRITERIA | PARTNER ELEMENT OPERATIONS | INTEGRATED OPERATIONS |
|---|---|---|
| PROGRAM CONTROL | ◒ | ● |
| PROGRAM SAFETY AND SYSTEM INTEGRITY | ◒ | ● |
| EFFECTIVE USER OPERATIONS | ◒ | ● |
| SUBSTANTIVE INTERNATIONAL PARTICIPATION | ● | ◒ |
| ASSEMBLY AND EVOLUTION | ◒ | ◒ |
| OPERATIONS COST EFFECTIVENESS | ◒ | ● |
| **RELATIVE RANK** | 2 | 1 |
| ADVANTAGEOUS - ● | ACCEPTABLE - ◒ | UNACCEPTABLE - ○ |

**Table IV-1 Operations Control Options Assessment**

greater challenge than Integrated Operations. In the context of normal operations, the separation of utilization and operations planning necessitates extra steps in developing both Tactical Operations Plans and Flight Increment Plans. Coordination of system support and user operations support is also a much more difficult management task, as the activities which could, or which might, affect more than one element would have to be coordinated through multiple system support centers. A distributed authority system would also inhibit the flow of "lessons-learned" across elements in the Program.

The system's ability to handle off-nominal events would pose a more significant challenge. A major system failure in one element, or failure of a distributed system, will require a concerted response; separation of decision making authority would require elaborate contingency plans worked out in extreme detail.[8] Such a contingency would also require procedures for quickly determining the severity of an event. (At what point does an anomaly justify integrated action or assumption of NASA control of partner elements?)

The integrated operations framework relies on a strongly centralized planning approach to permit maximum coordination of broadly distributed activities. Thus, planning activities at each level (strategic, tactical and execute) are carried out under the influence of one central organization, led by NASA but staffed by all partners. At the policy level, selection of users and onboard activities is handled in a distributed manner, allowing user disciplines to set priorities and select users independently, but manifesting is performed centrally. Similarly, at the Program Integration and Program Execution levels, each user activity is planned independently, but all are coordinated through a central planning body.

The integrated planning effort ensures the most efficient distribution and utilization of scarce onboard resources, and allows a quicker response for replanning due to unforeseen opportunities. It also encourages the development of consistent end-to-end user accommodation and crew procedures (since all partners are working to the same schedules and parameters). Integrated planning would cut down on duplication of effort, and ensure cost-effective use of planning staff. Finally, a unified approach will allow for an effective conflict resolution process. The Task Force concluded that these advantages outweighed the disadvantages of the centralized planning approach (i.e., complex formulae/groundrules for provision of operations services and diminished autonomy of the partners).

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[8] *This would require major management investments, and would still leave the possibility that unforeseen anomalies would leave the partners debating over appropriate delegation of authority rather than focusing on the problem at hand.*

### Program Safety and System Integrity

The SSOTF concluded that there is no prima facie reason why a framework based on Partner Element Operations could not be conducted in a safe manner, but the collective intuition and experience of the Task Force found little incentive for this approach from the safety and program integrity perspective.

The basic concern is that a Partner Element Operations framework requires additional management and operations interfaces (both personnel and equipment), and therefore increases the opportunity for miscommunication or outright command/control breakdown. The separation of operations also suggests that over time, each element would develop its own operating procedures and standards. Configuration management is greatly complicated when sustaining engineering functions are not only geographically distributed but organizationally separated as well.

Additionally, it was recognized that many operations may extend beyond the boundaries of one element. (For example, the MSC could be used to mount a payload on the JEM's exposed facility.) Separation of operations authority and experience suggests that the ability of the two elements to "act in harmony" may be compromised.

The SSOTF strongly felt that hazardous operations activities had to be centralized (for example, materials science work with toxic substances). The lack of a single system-level control for ongoing element operations would be analogous to having two air traffic controllers monitoring flights in the same geographic locale, but having separate supervisors. Given the potential cost of mistakes, the risk was not considered warranted.

The lack of commonality in procedures development, crew training (and related control mechanisms), and the likely differences in operations among system hardware and software elements, introduces the possibility of inadvertent mistakes by the crew, especially in off-nominal situations. A major advantage of the integrated crew approach of the Recommended Framework was that it would provide all crew members with a standardized approach to the understanding of Station systems and performance characteristics, and as important, would promote a team approach to operations. (This affects not only safety, but user operations as well.)

### Effective User Operations

The impact on user operations will be severe if a Partner Element Operations approach is selected. As noted above, the separation of utilization, planning and operations by element greatly increases the coordination requirements among elements: separate manifests must be drafted for each element, revised to be consistent within the element, then be adjusted to be consistent with overall manned base activities, etc. This will greatly inhibit the flexibility of users to make adjustments to their experiments, or for "quick is beautiful" payloads to be manifested.

Resource allocation would still be determined by international negotiation, similar to the recommended framework. However, resources would be distributed in "blocks" to the element operators, who would perform manifesting for each element separately. Each partner would develop element CUPs, TOPs and increment plans which would require a compatibility check and resolution of incompatible manifesting.[9] Such a system could adversely impact the activities of U.S. users who are manifested in partner modules and must work with the foreign procedures. Significantly, as much as 50% of the available resources in the partner elements could be allocated to U.S. users. Separation of manifesting suggests that users may have to learn the intricacies of three separate manifesting procedures.

The SSOTF also judged that Partner Element Operations would eventually result in a lack of commonality in element flight support equipment. This issue is particularly important in user interfaces: rack and interface commonality will be an absolute requirement in order to permit distributed payload/rack integration operations. Furthermore, non-standard interfaces would force users to understand and meet several sets of requirements if they wished to utilize the capabilities of different Station elements.

Partner Element Operations would also severely inhibit the Station's productivity to users on-orbit. A crew member dedicated to one module or specific set of payloads could suboptimize Station capabilities. For example, if one crew member is sick, crew dedicated to other elements may not have sufficient expertise to "fill in" and oversee some of the payloads and experiments for which the sick crew member was responsible.

### Substantive International Participation

The one area where the Partner Element Operations option was considered advantageous by the SSOTF was in the area of international participation from the perspective of the international partners. It assigns a much higher level of responsibility to the partners for operations planning, management and execution, and therefore more completely addresses their desires to quickly develop a comprehensive experience base in space operations.

While the Partner Element Operations concept would provide international partners with greater operations experience and responsibility overall, it might actually compromise some aspects of this objective. Partner Element Operations would complicate crew manifesting from the standpoint of providing recommended systems operations crew capabilities. Columbus and JEM astronauts would be required to perform both element systems and user support activities; hence it is unlikely that they would be trained to provide any specialized systems support capabilities such as in flight medical responsibility, the ability to operate the MSC, FTS, or any crew return systems. While the majority of these activities will fall to U.S. astronauts, the Partner Element Operations option suboptimizes both U.S. and partner crew operations for the following reasons: (1) a higher percentage of U.S. crew requirements will be dedicated to systems support (and correspondingly less would be available for user operations support); and (2) there would be no opportunity for foreign crew members to develop flight experience in such tasks.

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[9] *For example, three different SSUBs could develop increment plans which might place users with heavy power requirements all at the same points on the systems timeline, thus saturating the resource availability. Alternatively, one SSUB could assign a sensitive pointing experiment at the same time as another SSUB manifested a series of vestibular motion experiments.*

### Assembly & Evolution

Partner Element Operations and Integrated Operations are both acceptable options with regard to supporting evolution, although the Task Force felt that Integrated Operations would be more effective. In both cases, planned changes in systems configuration or user activity would require the approval of the partners, and systems upgrade DDT&E would most likely occur at the ESC where the element was built.

However, Partner Element Operations would adversely affect the ability to evolve for two reasons. First, it is likely that each partner would be proposing element upgrades which optimized performance of their respective elements; this might not always optimize the total system. (For example, separate power upgrades for each module may be less efficient than a block upgrade of the entire system.) Second, integration of proposed system upgrades would require coordination with the separate user, logistics and maintenance manifests of the element partners. Disintegration of unified standards and commonality would be more likely to occur, thereby raising not only a safety risk, but also making continued evolution increasingly difficult to plan and implement.

### Operations Cost Effectiveness

Both Integrated operations and Partner Element Operations should allow effective cost management. However, as the number of interfaces rises, the costs of coordination rise, and the likelihood of duplicated or unnecessary effort is also magnified. Extra layers of management for utilization and operations planning, separate facilities for system and user operations support and their geographic separation, all introduce new elements of cost. A related aspect is that Partner Element Operations would severely hinder the productivity of the crew (the scarcest and most costly Station resource) in terms of the amount of activity which it could perform in both routine and off-nominal situations.

In the final analysis, "acceptable" cost level is a policy determination, and Program partners could decide that the extra expense for Partner Element Operations is justified by its value to NASA's partners. The SSOTF, however, believes that for any operations budget, the ability to increase the safety of the system or its utility to users is a greater virtue, and hence should be promoted.

### Summary

Although the SSOTF did not recommend the Partner Element Operations option, it was recognized that a "workable" framework could be devised if political imperatives dictated such an approach. The Task Force judgment was that a framework based on Partner Element Operations would result in a significant sacrifice in the quality and efficiency of user support, as well as an increase in safety risk associated with hazardous operations. User support is a variable determined by Program management, and safety concerns can be met through acceptance and implementation by all the partners of suitable U.S. safety requirements. These are the key issues for resolution by the international negotiations. Depending on the negotiated position, the recommended framework of Integrated Operations could be significantly altered. Overall, Partner Element Operations is achievable at a cost in operational efficiency, but the majority of the SSOTF recommended framework could still be implemented and support this option.

## IV.D. PROPRIETARY USER OPERATIONS

Users from several demographic and discipline categories will require the ability to perform proprietary operations onboard the Station complex. Commercial users will require the ability to protect proprietary research and development efforts, as well as more extensive pilot production efforts. U.S. and international users will need to protect any activities that are covered by technology transfer laws. Additionally, the Department of Defense will require proprietary protection for sensitive research activities. The SSOTF accommodated these requirements wherever possible in the development of its operations procedures.

The requirement for proprietary user operations affects ground and onboard crew activities, data transmission, and pre and post-launch handling of the payload and its products. The major requirements of proprietary users, and the means forseen for handling them, include the following:

### Secured Data Transmission Capabilities

Since a large proportion of user activities will be handled via specialized User Operations Facilities (UOFs) on the ground, data regarding a payload's status and operations will be transmitted via the Space Station Information System. Furthermore, the payload owner will require interaction with the Station crew to monitor and direct the onboard activities. Both of these streams must be secured to avoid disclosing information concerning experiment hardware, goals and operating procedures, and results.

The SSOTF concurred with previous user studies which recommended that NASA provide an encrypted uplink to the Station, and that users will be responsible for protecting the data downlink as they see fit. NASA will also provide a privacy protected voice channel capability.

### Physical Isolation of Experiment and Crew Onboard

Proprietary operations will require that the experiment be shielded or isolated onboard the Station to avoid observation by crew members not directly involved in the effort. The SSOTF concluded that this requirement could be satisfied by the use of physical barriers (such as curtains or movable partitions), and would be considered in the manifesting and placement of payloads in the Station modules.

The SSOTF also recognized that a privately sponsored module may provide proprietary facilities on the Station, and the operations framework does accommodate the training and operational requirements of making such a module effective. A private module operator may also provide a corps of bonded astronauts for use in proprietary operations.

### Private or Bonded Astronauts

Some user operations may require the use of privately sponsored astronauts (Payload Scientists), or access to a bonded astronaut corps. The SSOTF framework provides for selection, training and operations with private Payload Scientists. Furthermore, existing NASA crew and operations policies will support the need for confidentiality in crew operations.

### Secured Pre and Post-Flight Facilities

Proprietary users will require access to secure facilities during payload and logistics module integration, launch, landing, and deintegration processes. The SSOTF framework allows users to integrate payloads into racks at off-site facilities, permitting the user to protect the payload as he sees fit. Once at the launch site before or after launch, the Logistics Operations and Pre/Post Flight Operations Offices will accommodate proprietary operations, or will interact with privately-provided services. Existing Shuttle policies will continue to protect proprietary interests during launch and return to earth.

### DOD Requirements

The operational requirements of the U.S. Department of Defense were considered within the context of proprietary operations. DoD was considered by the SSOTF as a strongly proprietary user, but other driving operational requirements were not addressed. This approach allowed the SSOTF framework to accommodate the research and development activities identified by DoD as its primary goal for Space Station.

## IV.E. STATION/STS OPERATIONS SYNERGY

The STS is currently the only transportation system baselined to support the Program, and will undoubtedly remain the primary system for transfer of men and material to and from the on-orbit elements. Since many of the operations functions performed for the Station must also be performed for the STS, there exist numerous areas of synergy where collaboration can improve overall efficiency. These opportunities exist in both the Development and Mature Operations Phases of the SSP.

The SSOTF effort has been paralleled by the Space Operations Task Force (SOTF) under the leadership of NASA Associate Administrator Robert Aller. This effort has examined ways in which NASA can streamline its institutional structure to delineate R&D activities from operations, and to evaluate how to integrate management and operations of its current and future operations programs. (These include the STS, TDRSS and Space Station programs.)

Cognizant of the SOTF activity, the SSOTF did not undertake a similar assessment. Instead, in developing the Recommended Framework, the Task Force members noted those areas where Station and STS operations organizations develop common policies, procedures, and specifications, wherever such standardization would enhance utilization and operations capability or reduce operations costs for a given level of activity.

### Two Caveats

Although the SSOTF supports the idea of maximizing synergistic operations between the STS and Space Station, it also cautions that the Space Station Framework will be more able than the current STS operations of incorporating new advances in automation and management systems. Consolidation could result in counterproductive "torquing" of Station operations if "non-standard" STS procedures and formats are used as the baseline. A second issue noted by the Task Force is the potential to use the operations funding of one program to help correct present or future problems in the other. In short, the Task Force suggests that any efforts to implement synergy be baselined on the most efficient approach, and such relationships should attempt to isolate or "fence-off" funding devoted to the respective programs.

### Development Phase Opportunities

During the Development Phase, the majority of Station assembly and verification operations will be performed by the STS organization, with crew remaining onboard the shuttle prior to the initiation of a permanently manned capability for the Station.[10]

Coordination between the STS and Station operations organizations can begin during the Station's Development Phase for systems "proof of concept" testing and crew development. Utilization of the STS as a Station operations testbed would allow high fidelity simulation of Station support facilities and procedures prior to deployment. Specific examples of prospective systems tests include: POIC/SSSC/MCC interface verification; verification of data/command links and interfaces from distributed user facilities (DOCs, ROCs, etc.) and verification of telescience communications with Station elements; and Station assembly techniques.

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[10] *The SSOTF assumed that prior to permanent manning,the STS crew would perform all external assembly tasks, while Station crew would perform the internal outfitting and verification of the manned base modules and common systems.*

STS flights also offer the opportunity to acclimate career astronaut Station crew members (Station Scientists and Operators) to on-orbit operations and training in IVA and EVA systems maintenance or payload operations techniques before beginning long-term Space Station flights.

## Mature Operations Opportunities

Station and STS operations activities will generate parallel functional requirements, and on any given day the planning and operations execution for one program will have an analog in the other. The major conceptual difference is that the Station activities will be weighted more towards multi-user payload operations, while the STS activities will be weighted more towards flight systems operations. Additionally, it is important to note that integration activities for the Space Station must be done on-orbit, while STS integration is performed on the ground.

### Strategic Utilization and Operations Planning

The Station and STS programs will have interfaces at all levels of utilization and operations planning. The development of the CUP must include assessments of transportation systems availability and capability, and transportation systems maintenance requirements. Strategic planning for Station systems growth and STS evolution should be coordinated. (I.e., the SSP should be a supplier of inputs to STS evolution planning, and SSP planning should take advantage of planned STS incremental or block upgrades.)

The interfaces for this activity will be at the Program Policy level for the SSP, and the Shuttle Operations (processing and flight operations) and Shuttle Orbiter (logistics) organizations for the STS. These organizations will also work together to coordinate ELV/OMV utilization and operations requirements at the CUP level.

### Tactical and Increment Operations Planning

At the Program Integration level, the necessary level of coordination must become much closer. TOP manifests must "align" Station increments with STS flight schedules and capabilities. For each increment identified in the TOP, the Station and STS organizations must develop and approve the detailed "up" and "down" manifests and transfer operations schedules. Engineering analyses required to verify payload-to-Station interfaces and those to support Shuttle integration will share many common data, tool and personnel requirements.

Logistics carriers integrated by the SSPF must be integrated into the STS by the launch site Shuttle payload processing organization. Late access payloads on the launch pad will require both STS and SSP launch site planning. Station planning for "payloads of opportunity" requires close monitoring of available space on STS Station support flights.[11]

Crew training facilities planning and crew training plans will have a high degree of synergy, and planning efforts for each will require coordination. (E.g., installation of a new capability for Station astronauts must not upset STS astronaut schedules, and vice versa.)

STS rendezvous, berthing and transfer of payloads into the Station will necessitate highly integrated procedures and planning for each end of this activity. Station payloads scheduled for return must be removed from the Station and reintegrated into the STS. Payloads returned from orbit must be deintegrated at the STS landing site and handed back to SSP representatives or users.

Areas where there will be obvious overlap (and hence opportunity for collaboration) include development of common procedures and standards for: safety assessments, hazard control, trajectory planning, rendezvous and berthing operations requirements (STS and OMV), and configuration control.[12] User accommodation requirements documentation (e.g., PIPs and Annexes) and support procedures should conform so that the STS operations organization is transparent to Station users.

### Operations Execution

At the Operations Execution level, synergies exist in two forms: the potential for collaborative performance of operations functions, and the potential to co-locate functionally and operationally related facilities. The former offers the potential to decrease the number of personnel required to perform operations functions; the latter offers the opportunity to improve the efficiency by enhancing the capability to coordinate operations in real-time[13] and to realize some potential savings in facilities and support costs.

A number of execution-level operations facilities have been identified which could be consolidated within a common structure, or from which the Station Program could take advantage of current STS capabilities and "corporate knowledge" to conduct Station operations.

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[11] *Station planners may also wish to use available space to launch material to the Station before it is needed, so that later flights can optimize unique or large payloads.*

[12] *Development of a common electronic database format, consistent with the TMIS, would allow this system to serve both Station and STS requirements.*

[13] *Empirical evidence from NASA's previous programs shows that replanning and contingency operations have been much more efficient when the operations organizations have been able to meet "face-to-face."*

### Logistics and Ground Operations Support

The process of preparing payloads for transport to the Space Station is one in which users hand off payloads to the SSPF, which in turn hands them to the STS payload integration organization, which then hands the payloads back to the Station crew for on-orbit integration. The engineering analyses which support this activity can be performed in an integrated fashion, and the "up-front" specifications for users can combine the limiting factors of each stage in the ground-to-Station transfer process.

Activities which can be developed in common format include test and checkout procedures, safety requirements and specifications, special handling procedures, and pad access procedures. The facilities used to train ground personnel in these activities can also be shared. Other opportunities include operation of an integrated LOC using a computerized database management system to store and track ORUs, STS spares and replacement items, and stowage maps. Another possibility is the training of a unified team for late access to the pad. (I.e., other missions may also require late access, and these could be supported by the same team trained in Station carriers.)

### Space Operations

In the Mature Operations Phase, the STS will directly support the Station during transfer operations. Transfer operations include rendezvous/approach, remote manipulator system/mobile servicing center operations (including payload transfer and berthing/docking of the Shuttle Orbiter), STS "down-load" management (Station products and waste to be returned), and OMV operations (including retrieval/placement of the COP or other spacecraft and in-situ satellite servicing). In addition, STS/Station systems management of such items as fuel cell water transfer and control systems will be closely coordinated, as well as potential crew recovery operations, the STS crew will be responsible for offloading cargo bay carriers with the RMS; the Station crew will use the MSCS to attach them to the Station as required. Transfer of payloads within the pressurized volume will be shared by STS and Station astronauts, which indicates that STS astronauts will need to know "basic" information about Station systems performance and safety procedures, and vice versa. Perhaps as important, for the seven to ten days that the STS is docked at the Station, the activities of fifteen crew members will need to be planned and integrated so as to ensure minimal impact on multi-increment, ongoing experiments and optimize performance of the expanded crew during this period.

### Space Operations Support

Space operations support for the Station and STS have a number of complementary functions. The command and control functions performed by the SSSC and MCC are co-located at JSC; interoperability of these facilities would provide a valuable backup capability in the event of a major support systems failure. Actual command and control procedures can also be standardized to a great extent, thereby offering the potential to move ground operators between the Programs with less retraining. (This would also embed a higher degree of understanding of operations requirements between the two support teams.)

Payload operations support for the programs also offers potential synergies. For example, the Spacelab Payload Operations Control Center and the POIC offer similar opportunity to develop interoperable and standardized user operations support facilities. Similarly, payload rack-to-element verification activities might be performed utilizing STS support facilities such as the Orbiter Processing Facility at KSC.

Finally, crew training, procedures and operations techniques development will need to be shared between the Programs, with numerous opportunities for joint control center and training facilities utilization. Specific facilities currently part of the STS Program which were identified by the SSOTF as useful for Station support include: weightless environment test facilities (located at JSC and MSFC); remote manipulator development facility (JSC); Shuttle mission simulator (JSC); shuttle engineering simulator (JSC); vacuum test chamber (JSC); and T-38/KC-135 acclimation training (JSC). Training schedules for these facilities will need to be closely coordinated between the Programs to assure the proper support to flight crews. (See Section IV.H. Special Topic on Crew Training.)

### Other Areas of Synergy

Another potential area for consolidating operations is outside contractor support services. The agency has, within the past few years, consolidated a number of its O&M and support analysis contracts. (Examples include the Payload and Ground Operations Contract at KSC, the Network and Mission Operations Contract at GSFC, and the STS Operations Contract at JSC.) The first attempt to provide SS/STS consolidated support is the proposed JSC Systems and Integration (S&I) contract which would provide integrated support to both Programs for joint training facilities development and operations. Further use of such consolidated contracting could help to curb operations costs and take advantage of the areas of facility synergy outlined above.

## IV.F. SAFETY

Safety requirements definition and documentation will be a NASA-controlled function for the manned base. Platform safety requirements will be the responsibility of the contributing partner. The overall safety review process is divided into two major areas: systems safety (all Station elements) supported by the Systems Safety Panel, and payload safety supported by the Payload Safety Panel. The two panels will report to the Program Integration level Program Safety Review Board (PSRB). The safety certification process for both will be similar to the process used in the STS Program, except that the PSRB will be chaired by an independent safety officer appointed by the Headquarters SRM&QA organization (Code Q). The SSSC will have overall responsibility for inflight operations safety controls, while the POIC will be responsible for monitoring prescribed user safety requirements.

### Systems Safety

The systems safety review process will be conducted in a similar manner to the STS. This requires that safety reviews be held in the same timeframe as design reviews (PDR, CDR) for the various Station hardware elements prior to assembly. The safety reviews will require that each element developer identify all hazards associated with that element and how those hazards will be controlled. These reviews will be conducted for all elements (U.S. and international partners) under the direction of the PSRB.

A Station Systems Hazard Control Plan (SHCP) will be required to assure that systems hazards are properly handled in the Mature Operations Phase (for systems upgrades and hardware additions resulting from evolutionary operations). The SHCP development and updating will be the responsibility of the Operations Flight Director within the SSSC. This plan will be developed in a similar manner to the STS Flight Rules, and maintained under configuration control once baselined. Once approved by the Systems Safety Panel, the SHCP is integrated with the equivalent payload safety plan by the SSSC and forwarded to the Program Safety Review Board for final approval. The integrated plan is termed an Increment Hazard Control Plan (IHCP). The systems safety review process is illustrated in Figure IV-1.

### Payload Safety

Ensuring the safe design and operations of user equipment in the Station Program will be a significant challenge. The quantity of user equipment and variety and number of differing payload operations will be much greater for the Station Program than for the STS. This, coupled with the expected 30-year duration of the Station Program, requires that a strong payload safety review process be set in place.

The SSOTF concluded that the Station payload safety review process should be similar to the STS Program with the following key exceptions: (1) the Program Safety Review Board will be chaired by an independent safety officer rather than by the Station Program (same as in the systems review process); (2) there will be a combined STS/Station review process for users rather than having users submit to separate Station and STS reviews; and (3) there will also be combined inflight and ground processing reviews.[14] Features which are similar to STS operations include:

Phased Safety Reviews: The payload is required to submit a safety analysis which identifies all hazards associated with the payload (both design and operation), as well as planned means for controlling each hazard. This "data package" will serve as the basic means of review by the relevant Program organizations involved in the review process.

Program Involvement: The safety review process must involve the appropriate engineering and operations

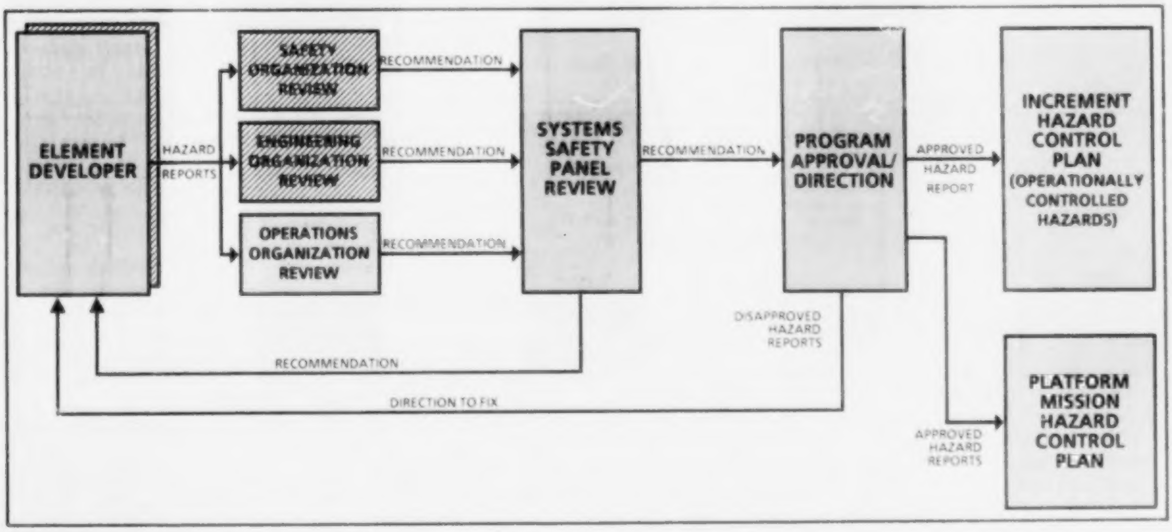
ELEMENT DEVELOPER
HAZARD REPORTS
SAFETY ORGANIZATION REVIEW
ENGINEERING ORGANIZATION REVIEW
OPERATIONS ORGANIZATION REVIEW
RECOMMENDATION
RECOMMENDATION
RECOMMENDATION
SYSTEMS SAFETY PANEL REVIEW
RECOMMENDATION
PROGRAM APPROVAL/ DIRECTION
APPROVED HAZARD REPORT
INCREMENT HAZARD CONTROL PLAN (OPERATIONALLY CONTROLLED HAZARDS)
DISAPPROVED HAZARD REPORTS
APPROVED HAZARD REPORTS
PLATFORM MISSION HAZARD CONTROL PLAN
RECOMMENDATION
DIRECTION TO FIX

Figure IV-1 System Safety Review Process

organizations of the Program. This includes review by the engineering community (SE&I or sustaining engineering) for the applicable Station elements in which the payload equipment will reside. All participating Station operations support organizations will support this review process as will representatives from the appropriate transportation and data systems services organizations.

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[14] *These last two features are intended to help reduce paperwork and costs to the users in the interest of providing user-friendly operations. Additionally, this provides for the development of standardized safety procedures between the Station and STS Programs where feasible.*

Review Board Control: A Payload Safety Panel will review all hazard control data submitted by the users and recommend changes in payload hardware, software and procedures if necessary for safety compliance. The Station Program will have the authority to direct that these changes be implemented. The various Program (and STS) organizations will provide their reviews and recommendations to this board.

The payload safety review process will result in a Payload Hazard Control Plan (PHCP) similar to the systems plan. Once this plan is approved by the Payload Safety Panel, it is sent to the SSSC for integration with the SHCP to form the IHCP. This process is illustrated in Figure IV-2.

### Operations Safety

As part of the safety review process, an Increment Operations Safety Review will be conducted prior to each manned base or platform increment launch. The SSSC will be responsible for integrating the systems and payload hazard plans into an Increment Hazard Control Plan for each increment. The IHCP will document all operationally-controlled hazards associated with the increment, and the controls which eliminate them. This plan will require Program Integration level approval by the PSRB prior to the increment launch, and will be under change control from that point until it is replaced by the next IHCP. All procedures or operations which involve hazards will require warnings in the document which highlight the hazardous procedures. Approval by the Operations Flight Director will be required to change any hazardous procedure or operation once the plan is under configuration control. Users will be required to demonstrate that their operations procedures comply with the hazard control plan, and that all hazardous procedures are appropriately flagged.[15]

When possible, hazardous operations should be controlled by positive inhibits onboard the Station elements. These inhibits could be in the form of Operations Management System software inhibits which prevent the hazardous operation from occurring until it is removed via direct command (remote or onboard). Removal of hazard control inhibits shall be the sole responsibility of the SSSC for the manned base (and platform transfer operations associated with the manned base), or the PSC for platform operations. The SSOTF concluded that in order to assure direct control over all hazardous activity, the enabling/disabling of any hazardous operations should not be allowed to be automated. Instead, this should require manual intervention to assure that a responsible individual has reviewed the situation and approved the operation (i.e., require positive control).

### Other Issues

In addition to constructing a recommended safety review process, the SSOTF made a number of general

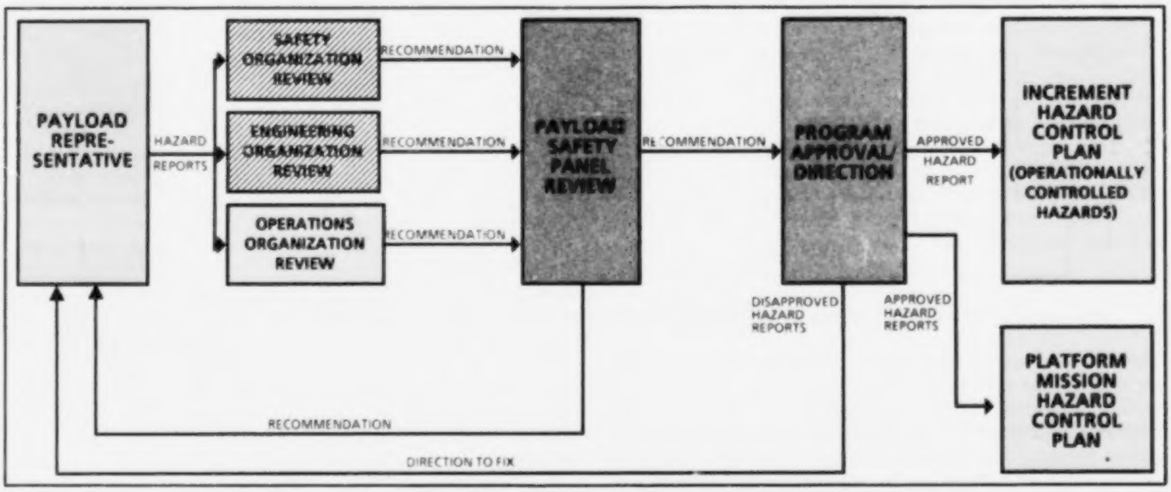
PAYLOAD REPRE-SENTATIVE
HAZARD REPORTS
SAFETY ORGANIZATION REVIEW
ENGINEERING ORGANIZATION REVIEW
OPERATIONS ORGANIZATION REVIEW
RECOMMENDATION
RECOMMENDATION
RECOMMENDATION
PAYLOAD SAFETY PANEL REVIEW
RECOMMENDATION
PROGRAM APPROVAL/ DIRECTION
APPROVED HAZARD REPORT
INCREMENT HAZARD CONTROL PLAN (OPERATIONALLY CONTROLLED HAZARDS)
DISAPPROVED HAZARD REPORTS
APPROVED HAZARD REPORTS
PLATFORM MISSION HAZARD CONTROL PLAN
RECOMMENDATION
DIRECTION TO FIX

**Figure IV-2 Payload Safety Review Process**

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[15] *This information will be supplied as part of the PHCP and will be integrated with the SHCP to form the Increment Hazard Control Plan.*

observations on Program safety. In order for the review process to be enforced, the Program should provide an adequate level of safety indoctrination for professional operators (crew and ground personnel), users and other support personnel. Only through the assimilation of safety requirements and standards by those operating the Station elements can a high degree of security in operations be ensured. In addition, during the Development Phase, contract and Work Package incentives are needed to improve safety through the proper design of the initial Station elements and hardware. The SSOTF felt that such incentives would be more effective in improving safety factors than would operationally imposed constraints on Station activity.

Finally, the SSOTF concluded that there is a need to develop quantitative methodology for performance of safety risk assessments. Such methodology would help to reduce the dependence on conservative assumptions which could unnecessarily reduce operations flexibility. As program experience develops, expected value estimates and "range of uncertainty" values could be used for safety assessments rather than simple conservative assumptions. However, for early operations the lack of historic data about running the Station will require continued reliance on conservative assumptions based on previous program experience (Skylab and Spacelab in particular).

## IV.G. PRICING POLICY

Industry experience and the STS pricing policy debates have shown that pricing structures can have decisive effects on the behavior of providers and consumers of complex services. Thus, it is important to assess the overall programmatic and political goals that a pricing strategy is to accommodate before developing the strategy itself. Since these goals are set by agents outside of the Space Station Program (primarily the Administration and Congress), the Task Force examined the effects that different policies would have, but did not recommend a particular approach.

The Task Force identified two possible objectives for a Space Station pricing policy which were considered most appropriate:

1) Primary emphasis on recovering NASA funds, while encouraging Station use.
2) Primary emphasis on promoting efficient use and management of the Space Station.

Once the overall goals of the pricing policy have been defined, a number of component issues must be resolved. In particular, the Program must decide: 1) the mechanism by which prices for resources should be set; and 2) what resources are to be separately measured, monitored and charged to customers. The Task Force considered each of these questions in light of the two types of overall goals outlined above.

### Types of Users

For the purposes of discussing pricing policy, Space Station users must be broken into several categories: users sponsored by NASA and the international partners; users from other U.S. government agencies; and commercial and non-partner foreign users. The applicability of the pricing policy and the means of exchange will differ for each of these user groups. However, once again, these issues will be determined by Congressional and Administration deliberations and can be accommodated within the framework outlined below.

### Setting Prices

### Cost-Based Pricing Structure

Federal law requires that agencies offering services that offer a particular benefit to one group, individual or industry must recover "all reasonable costs" incurred in providing these services. Traditionally, NASA has interpreted this requirement to mean that prices must be based on some measure of actual program costs. Such an approach could be used in establishing a Space Station pricing policy. One alternative would be to allocate Station costs to specific services or users and establish prices based on those costs.[16] Another would be to charge the user for the incremental cost of each service provided.

Either of these approaches would correspond to established tradition, and would permit relatively easy accounting procedures and calculations. Furthermore, full cost recovery could encourage users to minimize their use of particularly expensive services. However, such pricing is artificially set and hence does not accurately reflect market demand. Therefore, this structure does not provide useful information to the Program regarding growth requirements.

### Demand-Based Pricing Structure

A less traditional approach to pricing NASA services would be to design the pricing structure to reflect demand. Scarce resources would be priced higher than those for which there is little demand. Thus power required at peak usage times would have a higher price than the same power during a period of low-usage. Similarly, users would pay for priority: in case of interruption or decreases in the availability of resources, users who paid for high priority resources would receive priority (i.e., uninterrupted) service.

This approach could be taken one step further by establishing an auction or some similar method for selling Station resources. Each use class granted a resource block by the Space Station User Board could put its resources up for bids via an electronic bulletin board (or other system), and potential users would bid on those resources and time slots which they considered most useful. A "floor" or minimum price could be set to ensure that minimum cost recovery goals are met, or to encourage commercial use while recovering some portion of costs. Such a step would prevent the Program from selling resources for less than a "reasonable" price, and would allow users to plan for at least a rough estimate of costs. (They would know that costs could be no lower than a certain level.)

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[16] *It would be up to Congress and the Administration to determine what costs are to be recovered: full operations cost, full operations cost plus development costs, or full program costs.*

Any of these approaches would improve the effectiveness of the pricing structure in guiding Station operators in meeting user needs, and in guiding users to utilize Station resources. Priority or peak-level pricing, in particular, could encourage the optimum use of Station resources, while other demand-based posted prices would serve as guides to growth. Furthermore, a demand-based pricing structure could well recoup as much or more of the operating costs than a cost-based strategy due to greater and more efficient utilization. There are several establishing procedures for developing demand-sensitive pricing strategies; however, most require extensive information regarding user demand, and would need frequent adjustments during the early operations phase (a process which might not be politically acceptable and would not allow confident user planning).

The auction approach would resolve the issue of allocating scarce resources among users, and would provide strong signals to the Station operators as to which services or resources are most highly valued. This information would support efficient operations and evolutionary decisions. On the other hand, an auction approach would not provide NASA with the data required for budgetary planning. It also requires that the users be highly involved in and knowledgeable about the bidding process (not realistic for small or first-time users). Most importantly, the auction might eliminate small users from the program, allowing only those who can afford to pay high prices to participate.

### Resources to be Priced

The question of which Station resources are to be measured and priced separately will have a strong effect on the overall efficiency of the pricing approach. On the one hand, measuring and charging for resources individually allows greater management control, but also incurs a greater management cost. Charging for resources in packages or blocks would require less ongoing management, but would not allow for close monitoring and adjustment in users' actual resource demands.

There are three options regarding this issue: (1) monitoring and charging separately for each and every resource; (2) monitoring and basing prices on relatively few key resources; and (3) establishing prices on some other basis.

The first option is possible because of current plans to monitor and protect all interfaces providing resources to payloads and Station systems. However, as indicated above, costing out and charging for resources separately leads to increased management costs (i.e., in developing contracts, tracking costs, and billing), as well as increased hardware and operations costs (i.e., in installing and servicing the necessary monitoring equipment, and processing and transmitting the data). Furthermore, there are questions of procedure: should measurements of a user's resource draw be made on the user side of the resource interface, or on the systems side? Some resources (like thermal conditioning) may not be directly measurable in sufficient detail. However, since most of the monitoring equipment and procedures will be necessary for other purposes, the increased cost may be acceptable.

Basing prices on one or a few key resources (e.g., power) can respond to some of these issues by diminishing the number and types of resources which must be measured. Such an approach has been used for pricing Shuttle services: a user's price was based on either the length of the Shuttle bay his payload required or the weight of his payload, and this price entitled him to a package of "standard" services. However, NASA will need to understand the potential demand for Station resources in some detail in order to determine which key resources should be used as a basis. In addition, some method will have to be developed for allocating rights to the resources which are not monitored.

The third option would involve developing prices for users which do not refer to actual, measured resources usage. Some method of allocating overhead costs could be developed, but such an approach would neither give the appropriate signals regarding resource use to users or operators, nor necessarily be equitable, and would represent an abrupt departure from existing policies.

### Early Action Issues

Because of the effect that pricing can have on user payload design and planning, it is necessary that a pricing policy be established before major development efforts are underway. With a planned Station IOC of 1995, some payload development efforts will get underway in the next several years. As a result, development of a Station pricing structure (at least in broad outline) should be undertaken immediately.

## IV.H. CREW TRAINING

This section will detail the key aspects of the crew training philosophy, and review what training facilities are considered necessary to support Station operations. Fundamental to the training philosophy for Space Station is a commitment to attain as much commonality across the Program as is practical between the media, the curriculum, and the facilities that will be used for the training in order to minimize operations costs. In all instances, this commonality will have to be preserved and maintained through intensive coordination both between the NASA Space Station development centers, and between the NASA centers and international partners. As training curricula are developed and materials prepared, this coordination will have to be rigorously maintained to ensure that the most efficient and effective training is produced, and that all crew members are sufficiently trained to be able to safely and effectively perform their respective duties.

### Mature Operations Training Support

#### Planning/Scheduling/Coordination

The planning, scheduling and coordination of training activities will be a major task in the Mature Operations Phase of Station operations. Training facilities and aids will be located at operational centers in all parts of the U.S. and at the international partners' sites. The possibility for overscheduling of crew personnel and facilities is very real. Hence, extensive planning and coordination of training activities is necessary to prevent conflicts from developing.

For the Mature Operations Phase, a joint training coordination group is recommended. This Space Station Training Coordination Board (SSTCB) would be composed of members from all the NASA centers supporting Station activities, the international partners, astronauts, and safety personnel. This group would accomplish the scheduling and conflict resolution for all training requirements. The goals of the SSTCB would be to provide the following: coordination of training schedules and curricula; definition of training sources; definition and standardization of certification requirements and procedures; definition and implementation of commonality requirements; definition and coordination of simulation approaches and schedules; and definition and implementation of a centralized training records system. One of the major goals of the SSTCB would be to pursue and maintain common training methodologies, media, scheduling and execution among all participating organizations.

It is proposed that commonality in the training process be implemented through the following areas:

Common Training Manuals/Briefings: Documents and briefings developed at one center for Space Station training could be placed in a common data library (accessible through TMIS) where all participating groups could access them. This allows savings by avoiding the creation of redundant training documents or briefings. An additional advantage is that updates to a given document would be available instantly at all locations.

Common Computer Aided Instruction (CAI) Lessons: CAI is an increasingly important training aid in the space program. With common CAI equipment located at all centers, lessons developed at one center could be shared among all and the resource savings could be translated into additional or improved training in other areas.

Common Training Equipment: Use of common training hardware/software protocols will allow transportability of software between centers. The same equipment would not be required to be housed at each location since the use of common or compatible host software means that programs and models developed for simulators at one center could be utilized at another in a cost effective manner.

Common Training for Users: With the expectation that most Station users will have access to standard or common user interface equipment to operate Station experiments, a set of common user training standards will be developed to allow the most efficient training and minimum impact on the user's time.

Common Certification Methods: These will be useful to ensure that high standards of performance will be maintained among personnel at all centers. The certification process will include testing of individuals to ensure their knowledge for a given task. This certification requirement could be applied to all personnel in the Station Program, from ground to flight crew personnel.

Common Flight Data File Formats: Common FDF formats are used in both systems and payload operations. Beneficial reductions in the training process would be possible since several different types of checklists formats/standards would not have to be learned in each area.

**Facilities/Aids**

Briefings and training manuals should be developed and shared cooperatively with all participating centers. However, the major training facilities will be capital investments which must be located to provide the maximum benefit to the Program for the lowest cost. The major cost issue associated with training is the question of centralized versus distributed location of the key facilities.

In terms of convenience and productive use of training time, centralized training facilities, collocated with trainees where possible, would appear to be the obvious choice. This option requires that the appropriate hardware (real or mockup) and software be provided and maintained at the Space Station Training Facility (SSTF). Representative medium fidelity Japanese Experiment Module (JEM) and European Space Agency (ESA) modules as well as a high fidelity Mobile Service Center System (MSCS) trainer would be located at JSC in addition to the high fidelity training devices located in the respective countries. However, the training benefits of centralization are partially countered by the cost of maintaining the various systems in concert with the "home" configurations and the travel required to coordinate such facility compatibility.

Distributed training is also not a perfect solution. Although the facility may be located near the persons most qualified to do the specific training, coordination can become a serious problem as the organization tries to keep its training facilities in some common configuration. Additionally, students must perform all the training integration themselves and consequently may encounter problems on-orbit which were never presented on the ground due to equipment limitations.

Both of these options have merit; hence, a mixture of both concepts is visualized by the SSOTF. The U.S. will provide high fidelity training (using simulators and mockups as appropriate) on all U.S. and partner distributed manned base space systems in a central location. Also co-located with this capability will be high fidelity systems training involving crew habitation module operations, MSC operations, operations within the module interconnect nodes, operations within the cupolas, and rendezvous/proximity operations. Additionally, medium fidelity U.S. and partner laboratory module simulators will be provided at the systems training site in order to provide an end-to-end mission operations training capability. This group of training equipment is referred to as the Space Station Training Facility (SSTF). The SSTF will necessarily be located near the flight crew offices and near Program personnel responsible for integrated space systems operations and maintenance. Additionally, training devices shared with other programs (e.g., weightless environment training facility, Shuttle 1-G Trainer) will also be in close proximity to the SSTF. Various part-task trainers and training aids will be located close to the office areas utilized by the crews for each flight increment.

Additional high fidelity training for the JEM and Columbus module space systems operations (distributed and laboratory unique) and payload operations will be provided by NASDA and ESA, respectively within their operations support facilities. Canada will provide a high fidelity MSC simulator within its operations support facility. These capabilities will be most useful for early space systems training of foreign and domestic crew members, for training crew members in the operation and servicing of foreign user payloads, and for providing an ongoing sustaining engineering capability to the Program.

A high fidelity simulation of the U.S. laboratory module and its user support systems will be required as well. This simulator will be used for early operator training in the operation and maintenance of Program provided, laboratory-unique user support hardware and software, as well as for training in selected payload operations and servicing tasks performed for domestic and foreign users. To facilitate integrated manned base user operations planning, medium fidelity simulators of the Habitation module, nodes, Columbus module and JEM will be provided in proximity to the U.S. lab simulator. This group of training equipment is referred to as the Payload Training Integration Facility (PTIF) and will necessarily be located near the Program personnel who will develop the U.S. lab module and who will provide ongoing user integration functions for the Program

An overview of this partially centralized/partially distributed training approach is presented in Figure IV-3.

Combined training between the PTIF or SSTF lab module simulators and the POIC will occur on a regular basis. It will be here that the main portion of the crew's scientific training occurs after they have visited the investigator's home laboratory. Users will need to negotiate with NASA for funding of this training related to their experiments. (Only systems-related training is fully funded by the Program.) The simulator at the PTIF will be maintained in a "next-up" configuration (e.g., next increment payload complement), while the modules at JSC will be maintained in a "current" or "as being flown" configuration. There will be a constant flow of these experiment configurations from the PTIF, ESA or Japan to the SSTF as each flight increment proceeds through its training plan. These configurations may take the form of software models and of rack simulators, each of which will represent an equipment rack in the vehicle. A complete listing of training facilities and their use is contained in Table IV-2.

The increment training plans will provide instruction for flight crews, ground personnel from all locations, and for users. This total training program is

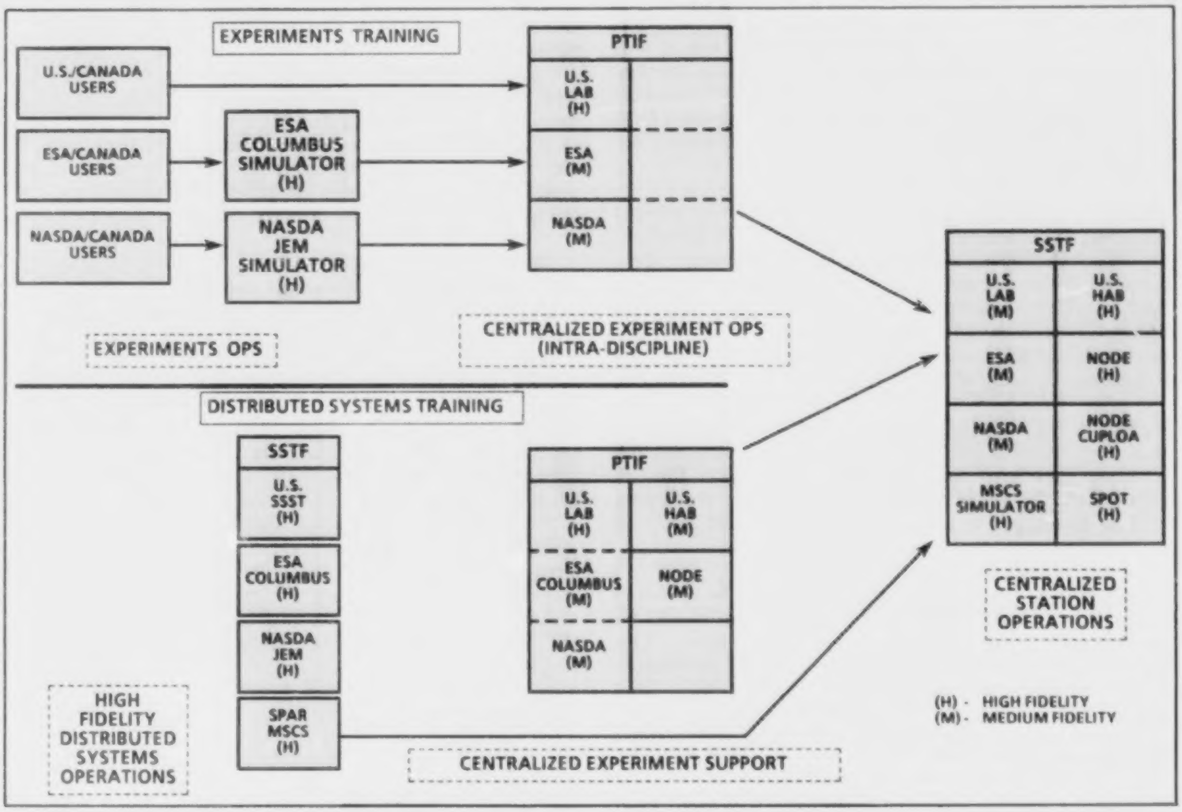

EXPERIMENTS TRAINING
U.S./CANADA USERS
ESA/CANADA USERS
NASDA/CANADA USERS
ESA COLUMBUS SIMULATOR (H)
NASDA JEM SIMULATOR (H)
PTIF
U.S. LAB (H)
ESA (M)
NASDA (M)
EXPERIMENTS OPS
CENTRALIZED EXPERIMENT OPS (INTRA-DISCIPLINE)
DISTRIBUTED SYSTEMS TRAINING
SSTF
U.S. SSST (H)
ESA COLUMBUS (H)
NASDA JEM (H)
SPAR MSCS (H)
PTIF
U.S. LAB (H)
U.S. HAB (M)
ESA COLUMBUS (M)
NODE (M)
NASDA (M)
SSTF
U.S. LAB (M)
U.S. HAB (H)
ESA (M)
NODE (H)
NASDA (M)
NODE CUPLOA (H)
MSCS SIMULATOR (H)
SPOT (H)
CENTRALIZED STATION OPERATIONS
HIGH FIDELITY DISTRIBUTED SYSTEMS OPERATIONS
CENTRALIZED EXPERIMENT SUPPORT
(H) - HIGH FIDELITY
(M) - MEDIUM FIDELITY

Figure IV-3 Space Station Crew Training Facilities/Flow

| | JSC FACILITY | PURPOSE |
|---|---|---|
| 1 | COMPUTER ASSISTED INSTRUCTIONAL TRAINERS (CAIT) | SELF-PACED TRAINING USING INTERACTIVE VIDEODISK, ARTIFICIAL INTELLIGENCE, ETC. |
| 2* | SPACE STATION SYSTEMS TRAINER (SSST) | DISTRIBUTED LAB AND HAB SYSTEMS, CORE SERVICES (INCLUDING NODES AND CUPOLA SIMULATION) |
| 3* | MEDIUM FIDELITY U.S. AND PARTNER LAB MODULE SIMULATORS | LAB SYSTEMS TRAINING PLUS EXPERIMENT MOCKUPS |
| 4* | STATION PROXIMITY OPERATIONS TRAINER (SPOT) | RENDEZVOUS, PROXIMITY OPERATIONS, MSCS SIMULATION |
| 5* | FLIGHT CONTROLLER TRAINING ROOM FACILITY (FCTR) | FLIGHT CONTROLLER DISCIPLINE TEAM TRAINING |
| 6 | SPACE STATION MOCKUP AND TRAINER FACILITY (SSMTF) | MANNED SYSTEMS, MEDICAL MECHANICAL TIMELINE TRAINING |
| 7 | WEIGHTLESS ENVIRONMENT TRAINING FACILITY (WETF) | EVA AND EVA RMS TRAINING |
| 8 | SPACE STATION SUPPORT CENTER (SSSC) | INTEGRATED SS CREW/GROUND TRAINING |
| 9 | MISSION CONTROL CENTER-HOUSTON (MCC-H) | INTEGRATED STS CREW/GROUND TRAINING |
| 10 | SYSTEMS ENGINEERING SIMULATOR (SES)<br>SHUTTLE MISSION SIMULATOR (SMS) | ENGINEERING, SIMULATIONS, RENDEZVOUS, AND PROXIMITY OPS |
| 11 | SHUTTLE MISSION SIMULATOR (SMS) | SHUTTLE TO SPACE STATION INTERFACE OPERATIONS |
| 12 | MOBILE SERVICING CENTER (MSC) ENGINEERING SIMULATORS | MOBILE MANIPULATOR ENGINEERING AND OPERATIONS INTERFACES INCLUDING: STATION, FREE FLYERS, PAYLOADS AND STS |
| 13 | MANIPULATOR DEVELOPMENT FACILITY (MDF) | SHUTTLE RMS INTERFACES WITH STATION ELEMENTS |
| 14 | ALTITUDE CHAMBER | EVA AND EMU TRAINING |
| 15 | KC-135 AIRCRAFT | 0-G TRAINING |
| | GSFC FACILITY | |
| 16 | EVA TRAINER | EVA TRAINING IN SUPPORT OF PLATFORM |
| 17 | INTEGRATION, VERIFICATION AND TEST FACILITY | PAYLOAD, PLATFORM, CUSTOMER SERVICING FACILITY, FLIGHT TELEROBOTICS SERVICER, AND LOW FIDELITY MSCS PART-TASK TRAINING |
| 18 | SHUTTLE BAY MOCKUP | PLATFORM SERVICING TRAINING |
| 19 | PLATFORM SUPPORT CENTER (PSC) | CONSOLE OPERATOR TRAINING FOR PLATFORM OPERATIONS |
| | MSFC FACILITY | |
| 20 | NEUTRAL BUOYANCY SIMULATOR | SELECTED PAYLOAD EVA TRAINING |
| 21** | HIGH FIDELITY U.S. LAB; MEDIUM FIDELITY PARTNER LAB MODULE SIMULATORS | LAB SYSTEMS TRAINING PLUS FLIGHT-LIKE EXPERIMENTS OR MOCKUPS |
| 22 | PAYLOAD OPERATIONS INTEGRATION CENTER (POIC) | PAYLOAD OPERATIONS CONSOLE TRAINING FOR POIC OPERATIONS |
| 23 | 1-G MOCKUP FACILITY | MODULE PART-TASK TRAINING INTEGRATED PAYLOAD TRAINING |
| 24 | 6 DEGREE-OF-FREEDOM SIMULATORS | PROXIMITY OPERATIONS, TELEROBOTICS TRAINING |

**Table IV-2 Training Facilities Utilized By The Space Station Program**

|  | LeRC TRAINING FACILITIES FOR SSP | PURPOSE |
|---|---|---|
| 25 | ELECTRIC POWER SYSTEM CONTROL SYSTEM TRAINER | SELF-PACED COMPUTER-BASED TRAINING FOR ELECTRIC POWER SYSTEM CONTROL SYSTEM OPERATORS |
| 26 | OPERATIONS SUPPORT CENTER (LERC's ESC) | FULL-SCALE STAND-ALONE AND INTEGRATED TRAINING FOR ELECTRIC POWER SYSTEM GROUND AND FLIGHT OPERATIONS |
| 27 | ELECTRIC POWER SYSTEM ORU MOCKUPS | TRAINING ON FULL SIZE ELECTRIC POWER SYSTEM ORU MOCKUPS FOR FLIGHT CREW PROCEDURES |
|  | CANADA FACILITY≠ |  |
| 28 | MANIPULATOR DEVELOPMENT & SIMULATION FACILITY (MDSF) | MSCS SYSTEMS AND MALFUNCTION PART-TASK TRAINING |
| 29 | AIR BEARING TRAINER | REDUCED FRICTION SIMULATION OF ZERO GRAVITY TRAINING FOR MSCS |
|  | ESA FACILITY≠ |  |
| 30 | COLUMBUS MODULE TRAINER | COLUMBUS MODULE SYSTEMS, MALFUNCTIONS, AND PAYLOAD TRAINING |
| 31 | WATER IMMERSION FACILITY | EVA RELATED TRAINING |
| 32 | ESA PLATFORM TRAINER | PLATFORM OPERATIONS AND SERVICING TRAINING |
|  | JAPAN FACILITY ≠ |  |
| 33 | JEM FLIGHT CREW TRAINER | JEM SYSTEMS AND MALFUNCTION TRAINING |
| 34 | JEM GROUND TEST MODEL | JEM SYSTEMS (HI-FI) HARDWARE/SOFTWARE TRAINING |
| 35 | JEM PAYLOAD OPERATIONAL TRAINER | JEM PAYLOAD OPERATIONS |
| 36 | JEM RMS TRAINING FACILITY | JEM MANIPULATOR OPERATIONS |
| 37 | SPACE STATION INTERFACE SIMULATOR | JEM/STATION INTERFACE TRAINING |
| 38 | WATER IMMERSION FACILITY | JEM PORCH AND RELATED EVA TRAINING |
|  | FACTORIES |  |
| 39 | FLIGHT HARDWARE MANUFACTURING FACILITIES | HANDS-ON FLIGHT HARDWARE PART-TASK TRAINING |
|  | PAYLOAD DEVELOPMENT/VERIFICATION |  |
| 40 | PAYLOAD EXPERIMENT DEVELOPER | LIMITED EXPERIMENT HANDS ON AND SCIENCE BACKGROUND TRAINING |
| 41 | PAYLOAD INTEGRATION/VERIFICATION | PROCEDURES VALIDATION AND EXPERIMENT INTERACTIONS |
|  | SPACE STATION |  |
| 42 | ON-ORBIT SPACE STATION | PROFICIENCY TRAINING ON SYSTEMS, RENDEZVOUS, PROXIMITY OPERATIONS, MSCS, MAINTENANCE, SAFETY EXERCISES AND INTEGRATED SIMULATIONS WITH THE GROUND |

*Comprise the JSC Space Station Training Facility (SSTF) **Comprises the MSFC Payload Training Integration Facility (PTIF)

≠These facilities are understood to be in the planning phase by the International Partners

Table IV-2 Training Facilities Utilized By The Space Station Program (Continued)

summarized in Figure IV-4. Each group of students will receive training proportional to their needs.

### Training Categories

Three major categories of training systems are recommended to be implemented. These are: team training, systems training; and payload training. Team training applies only to the manned base in support of flightcrew activities. Systems training and payload support training apply to all elements of the Station Program.

Team Training: This is an integrated training concept designed to create teams of personnel at each operations center and onboard the manned base who can work closely together. The goal with this type of training will be to develop behavioral skills in teamwork (create a "team feeling" for each increment crew and its supporting ground personnel).

Systems Training: This applies to ground support personnel who will be charged with operating the Station's systems. All ground personnel will receive a basic introduction to all the elements of the Space Station system (including the international contributions) via briefings, documentation, tours, etc. Additionally, advanced systems training for the ground personnel will be conducted in their areas of expertise utilizing single system trainers, multi-system simulations, mock-ups, etc. Flight Controller Training Rooms will be available in the SSOTF to support on-orbit systems training without interfering with the operations of the SSSC.

Payload Training: Payload controllers supporting payload operations, in addition to being given Station systems training as required, will be given specific training in payload systems and operations. Once again, such training will be user-funded although supplied by the Program. Introductory payload

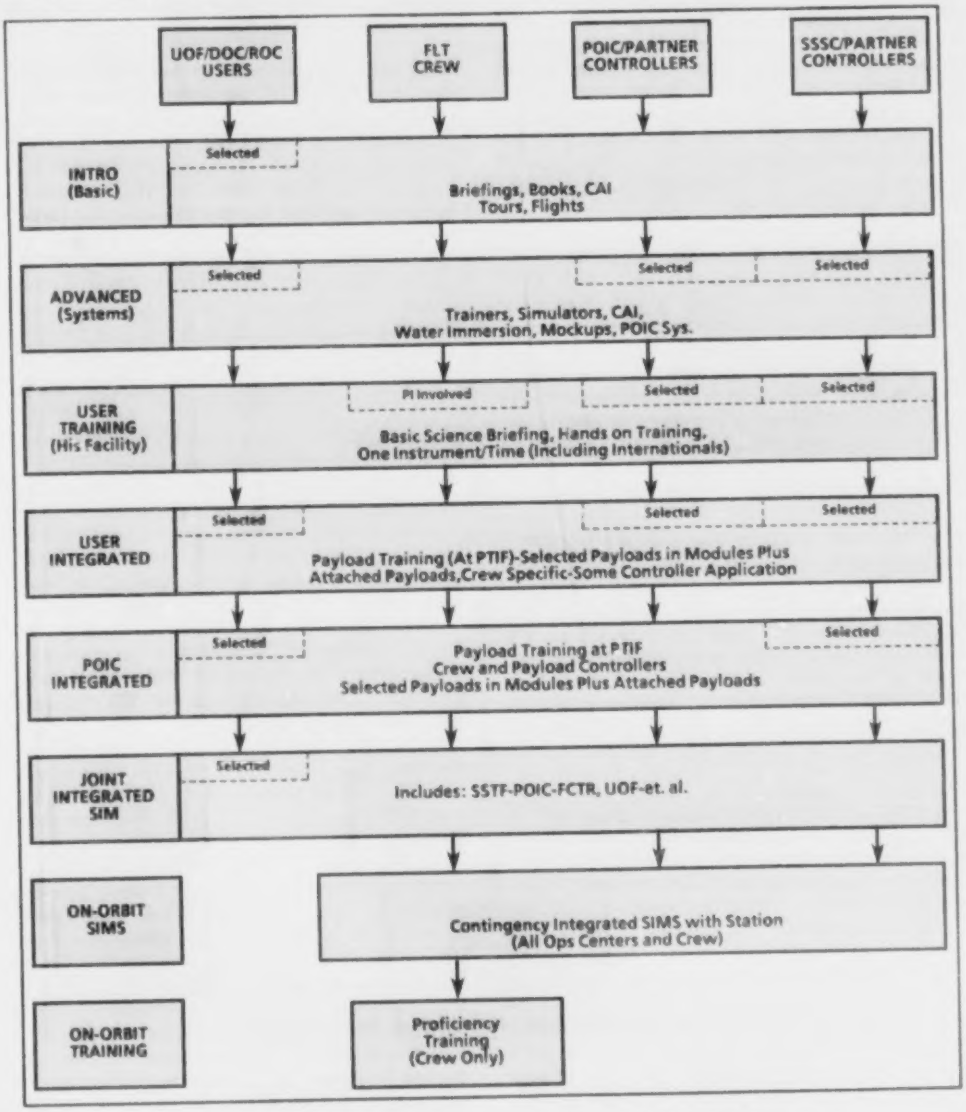

UOF/DOC/ROC USERS
FLT CREW
POIC/PARTNER CONTROLLERS
SSSC/PARTNER CONTROLLERS
INTRO (Basic)
Selected
Briefings, Books, CAI
Tours, Flights
ADVANCED (Systems)
Selected
Selected
Selected
Trainers, Simulators, CAI,
Water Immersion, Mockups, POIC Sys.
USER TRAINING (His Facility)
PI Involved
Selected
Selected
Basic Science Briefing, Hands on Training,
One Instrument/Time (Including Internationals)
USER INTEGRATED
Selected
Selected
Selected
Payload Training (At PTIF)-Selected Payloads in Modules Plus
Attached Payloads,Crew Specific-Some Controller Application
POIC INTEGRATED
Selected
Selected
Payload Training at PTIF
Crew and Payload Controllers
Selected Payloads in Modules Plus Attached Payloads
JOINT INTEGRATED SIM
Selected
Includes: SSTF-POIC-FCTR, UOF-et. al.
ON-ORBIT SIMS
Contingency Integrated SIMS with Station
(All Ops Centers and Crew)
ON-ORBIT TRAINING
Proficiency Training
(Crew Only)

Figure IV-4 Space Station Student Training Flows

training will be provided by the user/payload sponsor to include science background briefings, experiment objectives, and experiment operations. Payload skills will be developed and maintained through separate training sessions, during support to payload crew training and via integrated and joint simulations. Training objectives will be defined jointly by the user and the Program, and will reflect the respective responsibilities of each ground support position.

### Crew Training Scenario

As an illustration of how these various training programs and facilities will interact to support Station operations, the following crew training scenario has been developed. (See also the User Integration Scenario in Section III. D for further detail on training interfaces.)

Career U.S. astronauts (Station Operators and Scientists) who have been assigned to the manned base will commence with a series of training classes aimed at providing them with the requisite proficiency necessary to operate the distributed systems on the Station. This process will take about six months conducted on a part-time basis, and will commence 24 months prior to launch. This training will occur at the SSTF or at other facilities at JSC.

Once a crew is assigned to a flight increment, they will begin a training regimen which will last approximately 18 months (e.g., will begin 18 months prior to launch). Payload Scientists will be added at this point to make up the complete increment crew complement. Since they are not career NASA astronauts, Payload Scientists will not receive the basic Station systems training provided to the other crew members. Any systems and habitability (zero-g acclimation) training these personnel need will be provided later.

The first six months of increment-specific training will be accomplished as a team at the various user facilities associated with the team's projected flight increments. (Each team will be on-orbit for the duration of two increments.) Each individual payload investigator will be responsible for the training which the crew will receive while at his specific location. Scheduling coordination for the crew while taking part in this training will be the responsibility of the SSTCB located at JSC.

The following six months of training will generally be based at the POIC or the PTIF where the crewmen can work with the investigator's personnel and with PTIF training people versed in the payload problems which have occurred on previous flight increments. At this point the crew will spend increasing time on individual experiments (including brief return trips to the laboratories). More and more time will be spent operating groups of experiments, which could be discipline groupings, or other sets of payloads which have some functional affinity. Increasingly, the crew will operate in concert with the personnel who will be in the POIC and the relevant DOC/ROCs during their flight increments.

About six months before their flight, the crew begins to train in earnest in the PTIF with a selected complement of experiments. These sessions are conducted on an integrated basis with the POIC and the applicable ROC/DOCs whenever possible. During this time the Station Operators and Station Scientists work on the skills they will require for EVAs planned during their increments, and will maintain their proficiency with MSCS and other manned base systems tasks they will have onboard.

Three months before flight, the crew moves to JSC where their training continues in the SSTF and other JSC facilities. The concentration now is on ensuring that the crew comes together as a team, and that an affinity is also developing between the crew and the support personnel who will be on the ground during the first few weeks of their flight increment. It is at this point that the non-NASA crew members will receive the habitability training they require. During this period, all of the crew will work to maintain the systems skills they will need.

Beginning approximately ten weeks before launch, a small number of integrated simulations will be scheduled with a portion of SSSC personnel, along with personnel from the POIC and the User's ROC/DOCs. (See Figure IV-5.) These simulations will be designed to ensure that the team building process has occurred properly and that the training for the increment about to launch is properly completed. Finally, after launch, "on-the-job" training and proficiency maintenance will occur throughout the duration of both increments. The entire training cycle for Station Scientists, Station Operators and Payload Scientists is illustrated in Figures IV-6 through 8.

### Development Phase Training Requirements

The transition from a development phase orientation on assembly tasks to mature Station operations will not occur rapidly nor change the basic manner in which training is accomplished. Instead, there will be a gradual increase in the training load as more throughput is required to support the assembly of Station elements and the increasing level of user activity onboard. It will also be characterized by a separation of the STS and Station training operations as the Program accelerates and the dedicated resource base increases in size.

During the Station assembly period, training responsibilities should be shared between the Station and STS Programs. The STS Program should provide training support for all activities related to launch, rendezvous and docking, and basic assembly tasks (i.e., those tasks external to the manned base modules and requiring extensive RMS manipulation from the Shuttle or EVA) such as truss construction and module/node connections. The Station Program should be expected to provide training for activities related to the internal manned base components activation such as module outfitting, equipment verification and systems checkout, payload start-up, etc. In any case, during the assembly phase very close coordination of training requirements and procedures development will be necessary.

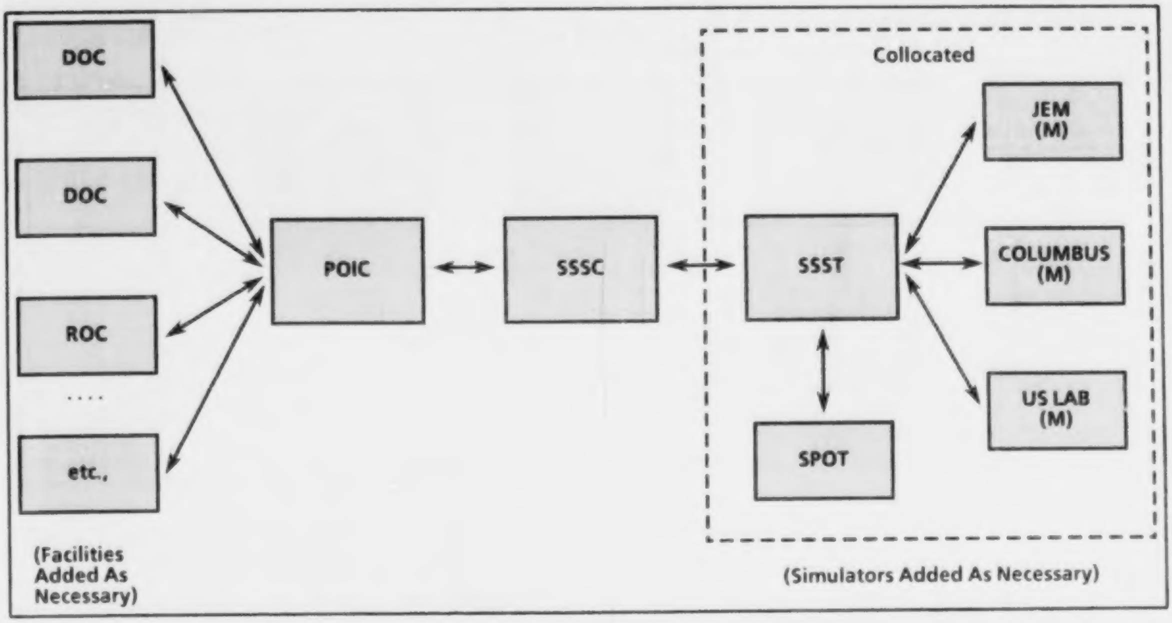
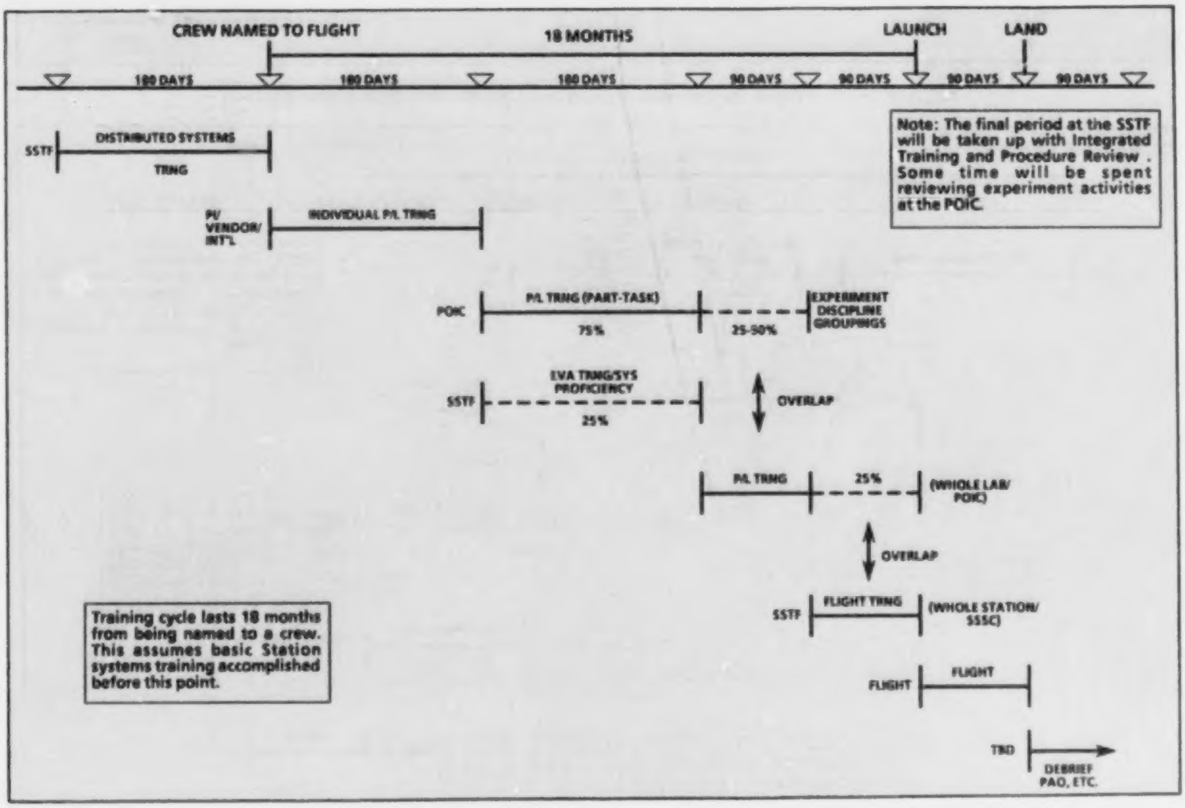

Collocated
DOC
DOC
ROC
....
etc.,
POIC
SSSC
SSST
JEM (M)
COLUMBUS (M)
US LAB (M)
SPOT
(Facilities Added As Necessary)
(Simulators Added As Necessary)

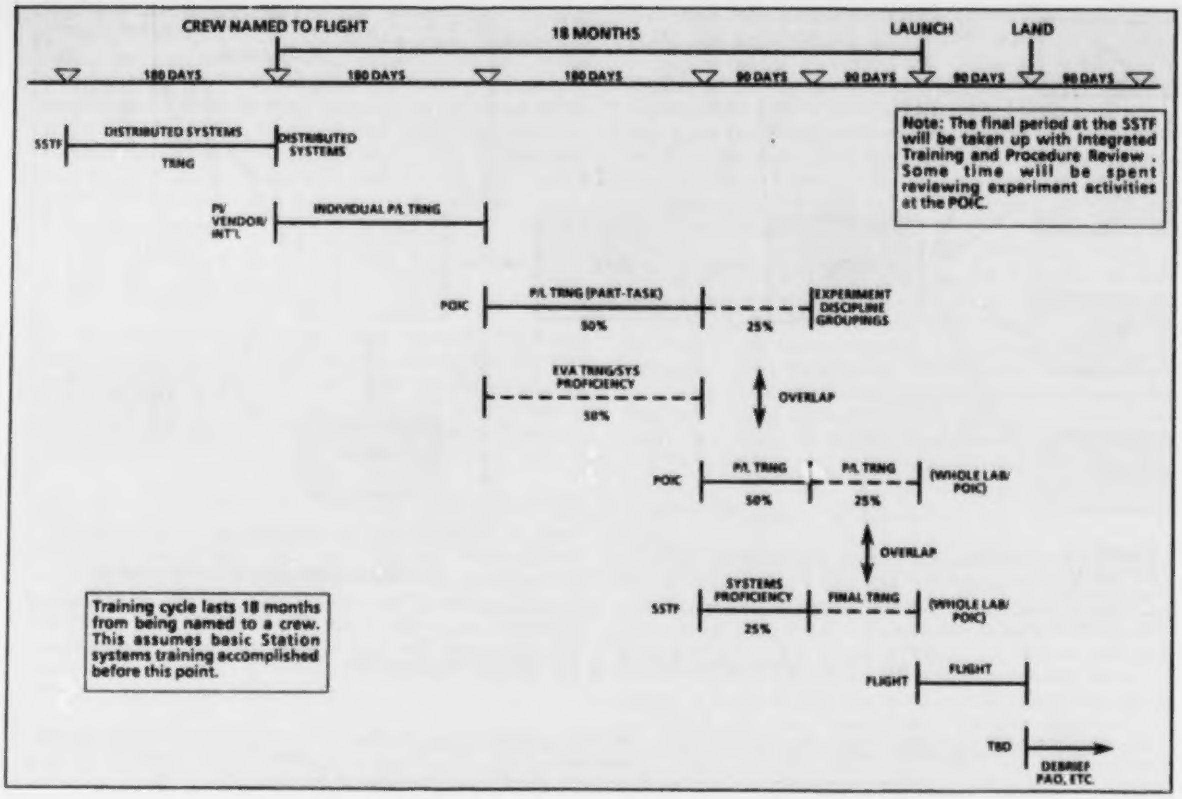
Figure IV-5 Integrated Training For Space Station Data Flow


CREW NAMED TO FLIGHT
18 MONTHS
LAUNCH
LAND
180 DAYS
180 DAYS
180 DAYS
90 DAYS
90 DAYS
90 DAYS
90 DAYS
SSTF
DISTRIBUTED SYSTEMS
TRNG
P/I VENDOR/ INT'L
INDIVIDUAL P/L TRNG
POIC
P/L TRNG (PART-TASK)
75%
25-50%
EXPERIMENT DISCIPLINE GROUPINGS
SSTF
EVA TRNG/SYS PROFICIENCY
25%
OVERLAP
P/L TRNG
25%
(WHOLE LAB/ POIC)
OVERLAP
SSTF
FLIGHT TRNG
(WHOLE STATION/ SSSC)
FLIGHT
FLIGHT
TBD
DEBRIEF PAO, ETC.

Note: The final period at the SSTF will be taken up with Integrated Training and Procedure Review . Some time will be spent reviewing experiment activities at the POIC.

Training cycle lasts 18 months from being named to a crew. This assumes basic Station systems training accomplished before this point.

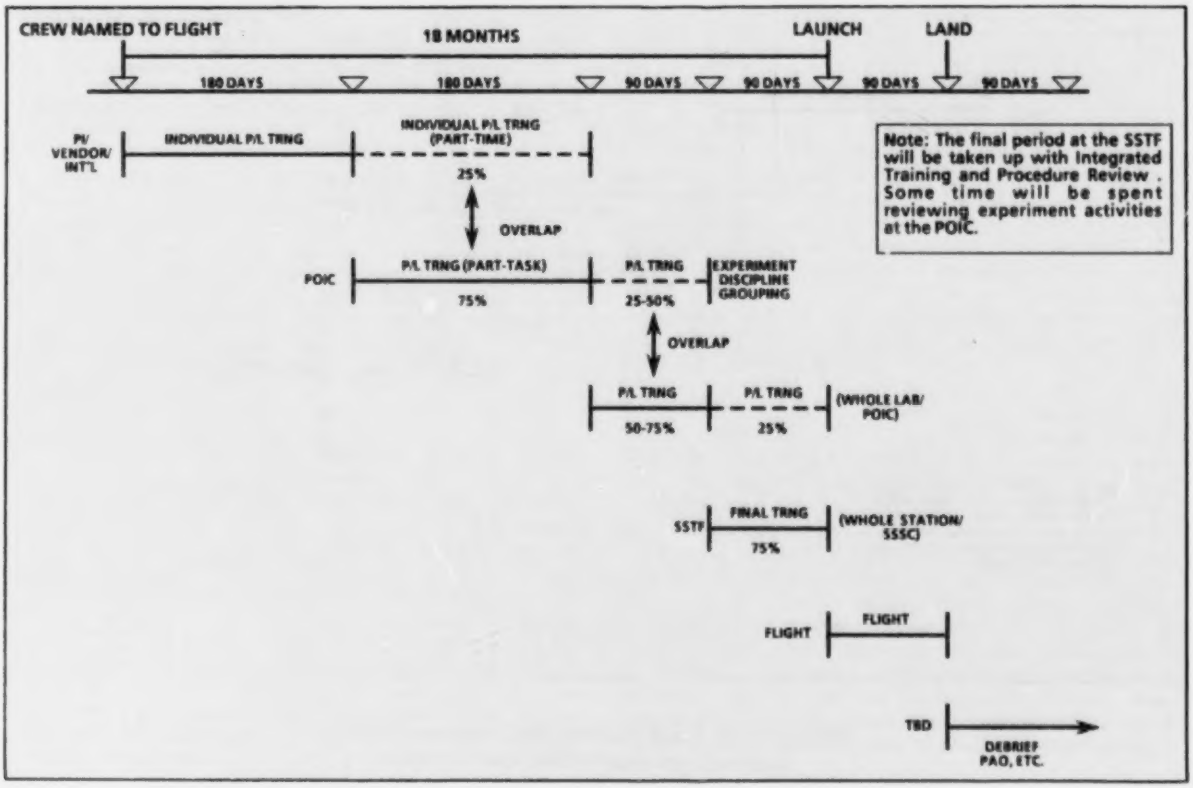
Figure IV-6 Flight Increment Training Cycle --
Station Commander/Station Scientist


CREW NAMED TO FLIGHT
18 MONTHS
LAUNCH
LAND
180 DAYS
180 DAYS
180 DAYS
90 DAYS
90 DAYS
90 DAYS
90 DAYS
SSTF
DISTRIBUTED SYSTEMS
TRNG
DISTRIBUTED SYSTEMS
P/ VENDOR/ INT'L
INDIVIDUAL P/L TRNG
POIC
P/L TRNG (PART-TASK)
50%
25%
EXPERIMENT DISCIPLINE GROUPINGS
EVA TRNG/SYS PROFICIENCY
50%
OVERLAP
POIC
P/L TRNG
50%
P/L TRNG
25%
(WHOLE LAB/ POIC)
OVERLAP
SSTF
SYSTEMS PROFICIENCY
25%
FINAL TRNG
(WHOLE LAB/ POIC)
FLIGHT
FLIGHT
TBD
DEBRIEF PAO, ETC.

Note: The final period at the SSTF will be taken up with Integrated Training and Procedure Review . Some time will be spent reviewing experiment activities at the POIC.

Training cycle lasts 18 months from being named to a crew. This assumes basic Station systems training accomplished before this point.

Figure IV-7 Flight Increment Training Cycle -- Station Operator


CREW NAMED TO FLIGHT
18 MONTHS
LAUNCH
LAND
180 DAYS
180 DAYS
90 DAYS
90 DAYS
90 DAYS
90 DAYS
P/ VENDOR/ INT'L
INDIVIDUAL P/L TRNG
INDIVIDUAL P/L TRNG (PART-TIME)
25%
OVERLAP
POIC
P/L TRNG (PART-TASK)
75%
P/L TRNG
25-50%
EXPERIMENT DISCIPLINE GROUPING
OVERLAP
P/L TRNG
50-75%
P/L TRNG
25%
(WHOLE LAB/ POIC)
SSTF
FINAL TRNG
75%
(WHOLE STATION/ SSSC)
FLIGHT
FLIGHT
TBD
DEBRIEF PAO, ETC.

Note: The final period at the SSTF will be taken up with Integrated Training and Procedure Review . Some time will be spent reviewing experiment activities at the POIC.

Figure IV-8 Flight Increment Training Cycle -- Payload Scientist

## IV.I. SPACE STATION INFORMATION SYSTEMS (SSIS)

The SSOTF Recommended Framework for the manned base and U.S. platforms will use the proposed SSIS as a key element in planning, managing, and conducting orbital operations. Although the Task Force did not address operations approaches for the European Space Agency platforms, these too will be supported by SSIS. The purpose of this section is to briefly describe and illustrate the SSIS and highlight differences between Task Force recommendations and the currently baselined SSIS.[17]

### SSIS Definition and Scope

The SSIS will be an end-to-end data and information system for the Space Station Program and its users. It is important to understand that SSIS will not be an "all-new," completely dedicated "system" for the Program. Rather, the SSIS is better characterized as a concept or virtual network consisting of both existing and planned operational elements provided by NASA, the international partners, and users of the Space Station. As defined in the SSIS Architecture Definition Document (SSIS ADD), the SSIS supports:

> ...the functions of prelaunch checkout, mission management, scheduling and control, software development, and the acquisition, transmission, recording, processing, accounting, storage, and distribution of data (including audio and video) produced by the Space Station Program, its users, and interfacing space and ground elements.

Although the SSIS is often thought of as only the flight critical operational end-to-end information system, it is apparent from this definition that the scope of SSIS activities is much broader. The SSIS includes real-time networks supporting flight activities (commonly referred to as "SSIS", a source of some confusion), and non real-time capabilities (i.e., the Technical Management Information System [TMIS] and the Software Support Environment [SSE]). The modifications to SSIS proposed by the Task Force recognize this broad scope and supports the concept of interoperability among the three systems.

### SSOTF SSIS Architecture: Core Systems and Interfaces

The operational SSIS contains a "core" set of space and ground elements. These elements provide the functionality required to provide direct support to flight operations and interfaces to external elements. Figure IV-9 illustrates this concept with the darker

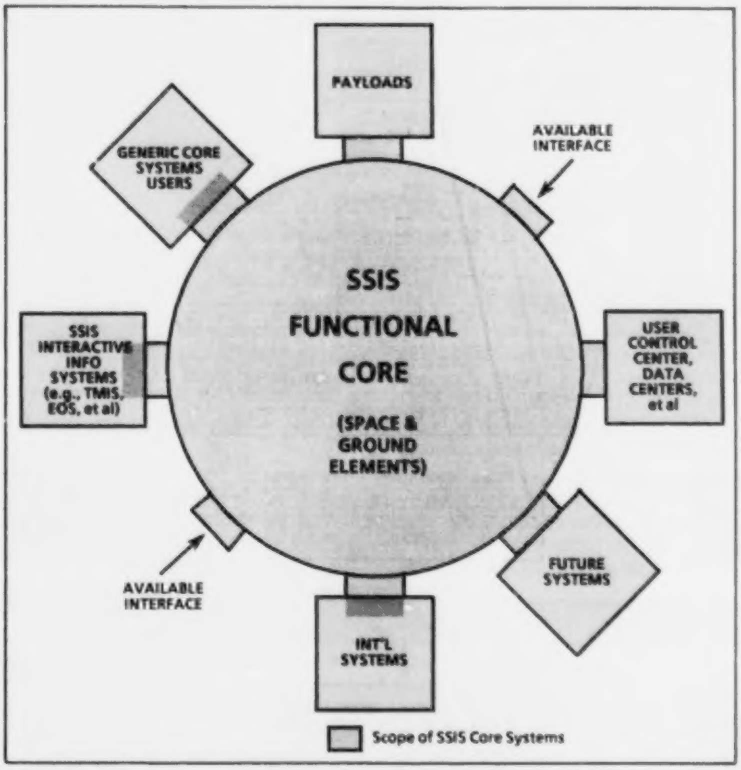

PAYLOADS
AVAILABLE INTERFACE
GENERIC CORE SYSTEMS USERS
SSIS FUNCTIONAL CORE
(SPACE & GROUND ELEMENTS)
SSIS INTERACTIVE INFO SYSTEMS (e.g., TMIS, EOS, et al)
USER CONTROL CENTER, DATA CENTERS, et al
AVAILABLE INTERFACE
FUTURE SYSTEMS
INT'L SYSTEMS
Scope of SSIS Core Systems

Figure IV-9 Scope Of The Space Station Information System

region representing the operational SSIS. Certain systems, such as TMIS and the international partner systems, have functional overlaps that are considered part of the SSIS core while other systems simply interface with SSIS through "gateways" managed and controlled by the Program. This Figure also makes it clear that the SSIS must be capable of expansion as overall Program capabilities evolve.

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[17] *The baseline is contained in the SSIS Architecture Definition Document (JSC - 30225). Other relevant SSIS requirements are contained in the Space Station Program Definition and Requirements Document (JSC - 30000, Sections 3 and 7) and "Customer Requirements for Standard Services Data Book" (JSC - 30221).*

The operational sub-networks within the SSIS core include onboard data and communications capabilities (e.g., Data Management System and Communications and Tracking System), ground control systems (e.g., the SSSC and POIC for the manned base; the PSC for platforms), user ground command, control, and data processing facilities (ROCs, DOCs, and UOFs), and the communications links between flight and ground elements. These links are provided by the TDRSS for space-to-ground communications and by NASCOM for ground data transport. The interface for the space links to the ground links occurs at the TDRS ground terminal at White Sands, New Mexico. The Goddard Space Flight Center (GSFC) manages and controls the TDRSS and NASCOM and provides data transport services in response to requests generated by the SSSC for the manned base and its users, the PSC for the platforms and their users, and the STS Mission Control Center (MCC) for the space transportation system, the OMV, and their users. Additional network capabilities are provided by other users (e.g., the proposed Science and Applications Information System [SAIS] for NASA's science users) or by the international partners for data transport between their sites.

Figure IV-10 illustrates a very simple version of the SSIS architecture as it will exist to support manned base users. Figure IV-11 illustrates a similar architecture supporting U.S. platforms. The remainder of the discussion on SSIS will use the architecture presented in Figure IV-10 as a "baseline"; platform operations are supported in a similar manner.

The basic SSIS elements will be provided by different organizations both within and external to NASA. Additionally, not all of the capabilities required by SSIS are dedicated to Space Station activities. (E.g., TDRSS and NASCOM support all near-earth orbiting NASA spacecraft.) These factors pose complex management and integration problems for the Program. To assist in resolving these problems, the Task Force recognized the need to have a single organization responsible for definition and control of SSIS architecture requirements.

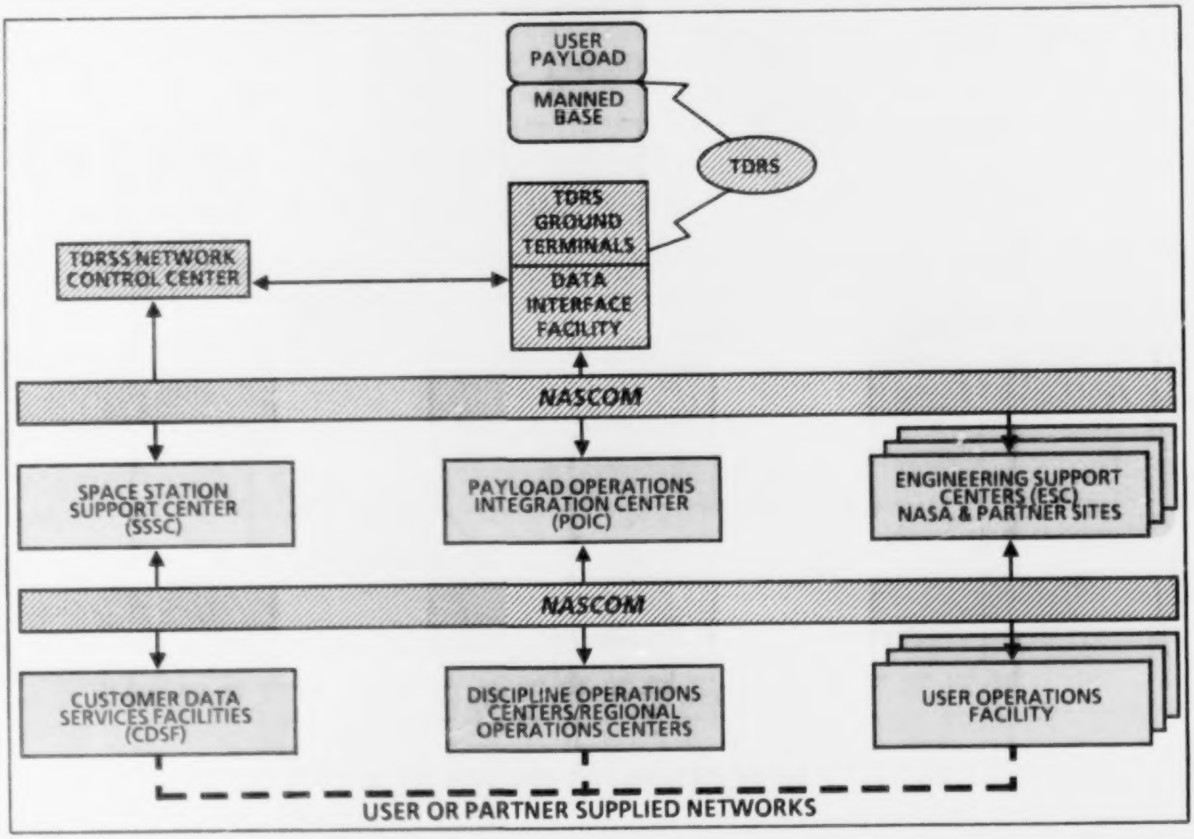
USER PAYLOAD
MANNED BASE
TDRS
TDRS GROUND TERMINALS
DATA INTERFACE FACILITY
TDRSS NETWORK CONTROL CENTER
NASCOM
SPACE STATION SUPPORT CENTER (SSSC)
PAYLOAD OPERATIONS INTEGRATION CENTER (POIC)
ENGINEERING SUPPORT CENTERS (ESC) NASA & PARTNER SITES
NASCOM
CUSTOMER DATA SERVICES FACILITIES (CDSF)
DISCIPLINE OPERATIONS CENTERS/REGIONAL OPERATIONS CENTERS
USER OPERATIONS FACILITY
USER OR PARTNER SUPPLIED NETWORKS

Figure IV-10 Manned Base SSIS Architecture

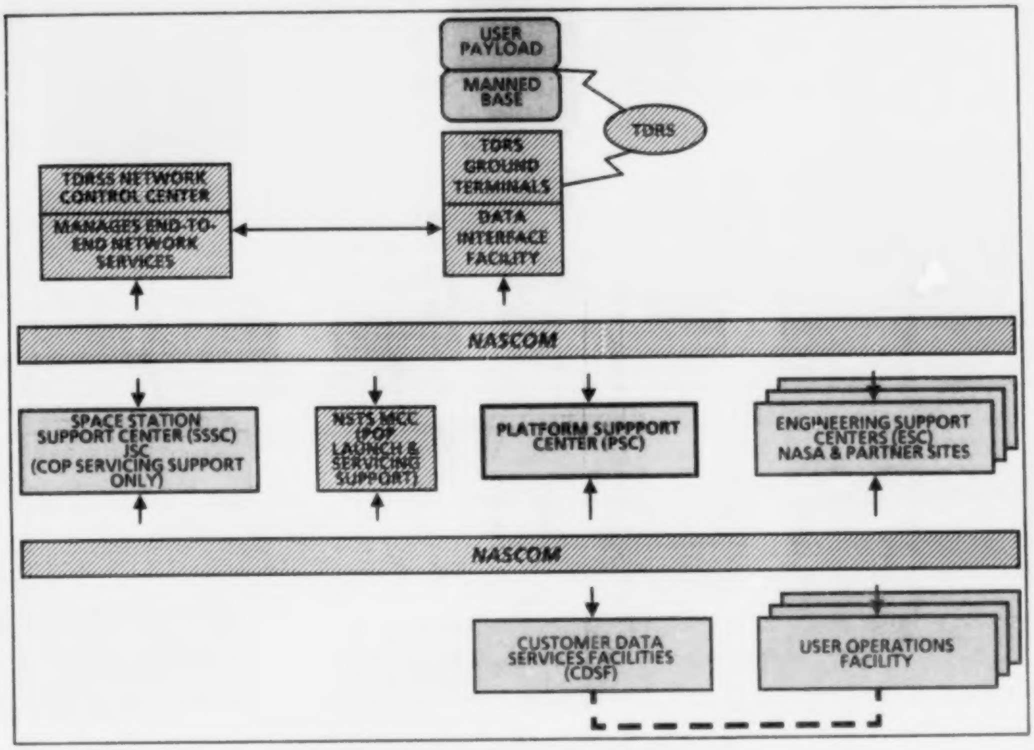
USER PAYLOAD
MANNED BASE
TDRS
TDRS GROUND TERMINALS
DATA INTERFACE FACILITY
TDRSS NETWORK CONTROL CENTER
MANAGES END-TO-END NETWORK SERVICES
NASCOM
SPACE STATION SUPPORT CENTER (SSSC) JSC (COP SERVICING SUPPORT ONLY)
NSTS MCC (POP LAUNCH & SERVICING SUPPORT)
PLATFORM SUPPPORT CENTER (PSC)
ENGINEERING SUPPORT CENTERS (ESC) NASA & PARTNER SITES
NASCOM
CUSTOMER DATA SERVICES FACILITIES (CDSF)
USER OPERATIONS FACILITY

Figure IV-11 Platform SSIS Architecture

### Data Flow Overview

The SSIS is a critical, and limited, resource in support of Program operations. Since SSIS is an international network with various elements being provided by different organizations, early and effective information systems planning is vital to successful operations. In developing the CUP, TOP and FIPs, Program system requirements and user requirements must be balanced against SSIS capabilities to ensure the system is correctly configured to provide the necessary end-to-end support.

During Program Execution activities, planning and managing the SSIS is a continuous process as new users are added/dropped from the configuration and as data traffic loads vary with configuration and time. The four phases of this process are: controlling access to the network; planning processing, collection and routing; providing support to users for end-to-end connectivity; and overall network management. The desired end result of this process is continuous, reliable, and "transparent" communications services between ground controllers (both system and users) and the orbiting elements. This transparency is illustrated by telescience operations in which the SSIS permits authorized users a direct, real-time communications path between the user's facility and the user's payload.

Figure IV-12 illustrates the Task Force approach to operations planning and scheduling. As illustrated in these diagrams, the services provided by both TDRSS and NASCOM are treated as "transparent" data buses through which all operational data flows between the ground and flight elements. The user submits a service request to the POIC where all user service requests are consolidated and transmitted as an integrated request to the SSSC. The SSSC performs an additional integration task by consolidating system requirements with those of the users. This completed service request is then transmitted to the Network Control Center (NCC) for implementation.

### Telescience, Access Control, and Safety

The Task Force fully endorses the concept of telescience in support of user operations objectives.[18] As noted above, this concept provides the authorized user with direct links to the user's payload. However, this approach must be balanced with system and operational safety requirements. Safeguards in the

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[18] *As defined by NASA's Task Force for Scientific Uses of Space Station (TFSUSS), telescience is "the direct, iterative, and distributed interaction of users with their instruments, databases, specimens, and data handling facilities, especially where remote operations are essential." Generally, users desire to conduct operations from their home facilities. SSIS must support telescience activities during preflight, flight, and postflight operations.*

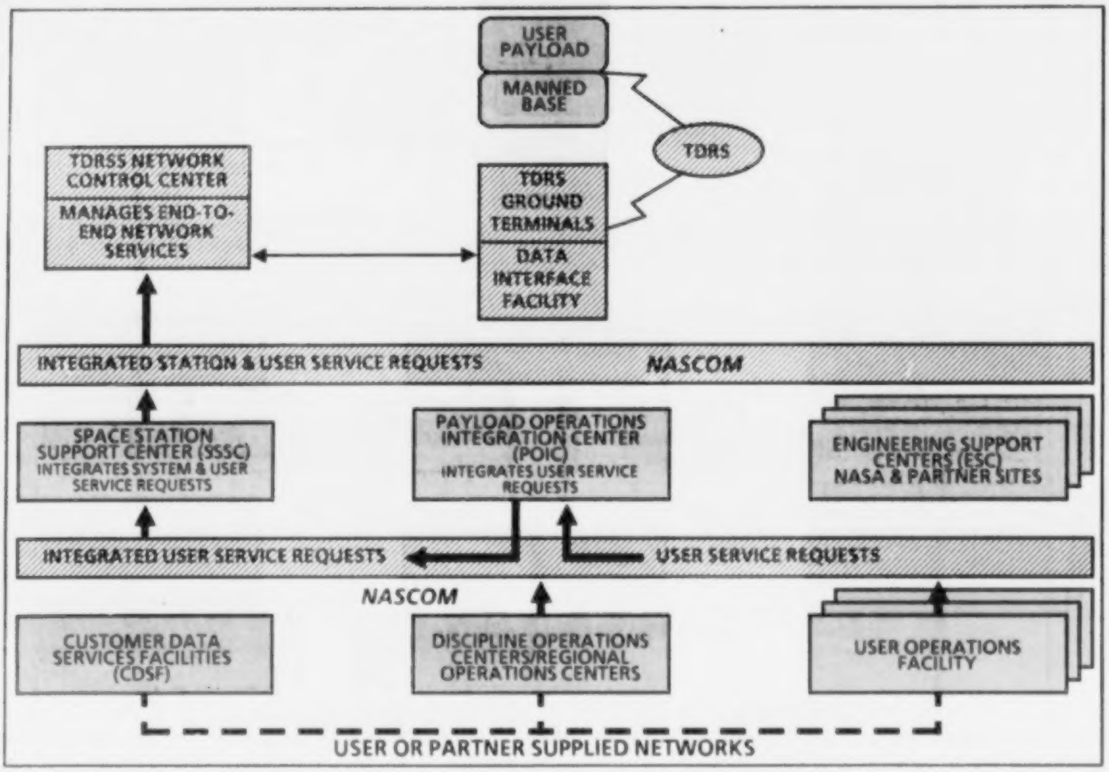
USER PAYLOAD
MANNED BASE
TDRS
TDRSS NETWORK CONTROL CENTER
MANAGES END-TO-END NETWORK SERVICES
TDRS GROUND TERMINALS
DATA INTERFACE FACILITY
INTEGRATED STATION & USER SERVICE REQUESTS
NASCOM
SPACE STATION SUPPORT CENTER (SSSC)
INTEGRATES SYSTEM & USER SERVICE REQUESTS
PAYLOAD OPERATIONS INTEGRATION CENTER (POIC)
INTEGRATES USER SERVICE REQUESTS
ENGINEERING SUPPORT CENTERS (ESC) NASA & PARTNER SITES
INTEGRATED USER SERVICE REQUESTS
USER SERVICE REQUESTS
NASCOM
CUSTOMER DATA SERVICES FACILITIES (CDSF)
DISCIPLINE OPERATIONS CENTERS/REGIONAL OPERATIONS CENTERS
USER OPERATIONS FACILITY
USER OR PARTNER SUPPLIED NETWORKS

**Figure IV-12 SSIS Operations Planning And Scheduling**

SSIS will ensure controlled access, and that such access will be limited to approved individuals, equipment and facilities. The Task Force also recognized the need for positive mechanisms prohibiting the overload of critical Station systems as well as developing positive, crew-operated inhibits/interlocks for hazardous operations (e.g., articulating a telescope during EVA, proximity operations, outgassing, servicing, etc.)

A key feature of the telescience concept is the ability of users to work freely within negotiated "envelopes." The envelope (one of many onboard data bases) describes the resources (e.g., power, bandwidth, crew time, etc.) necessary to support a user activity. To protect the manned base, the crew, and the user's payload, the SSIS must support positive access control. There are two types of control. The first simply establishes the identity of a user attempting to access the SSIS. The second uses predefined tables (the envelope) to ensure that the authorized user operates approved equipment at approved times, within the negotiated envelope.

Figure IV-13 illustrates the data flow path for the commands and return telemetry for such an approved user. As illustrated, the SSIS services are provided automatically to the user at the scheduled time and no additional interaction is necessary between the user and the Program control centers (i.e., POIC, SSSC, and NCC). The SSIS also supports the transmission and onboard execution of Stored Program Commands. In this mode of operations, the user develops command loads well ahead of the scheduled activity and they are executed automatically by the user's payload at the scheduled time. The results of the activity (return telemetry) may be either stored onboard or on the ground for later delivery or delivered in "real-time" to the user's facility.

In all cases, the results of the payload activity are monitored by an onboard SSIS system: the Operations Management System (OMS).[19] Normal, approved payload operations are allowed to continue so long as they do not exceed the authorized envelope. Payload operations exceeding the envelope or causing a hazardous drain on available resources will be terminated by the OMS.

To support the development and implementation of systems and operational techniques capable of supporting telescience, the Task Force developed a requirement for a set of end-to-end telescience scenarios. These scenarios should be performance based models of various telescience operations. Developed by the Program with support from the user

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[19] *The OMS is a planned operating system and applications enhancement to the baseline DMS.*

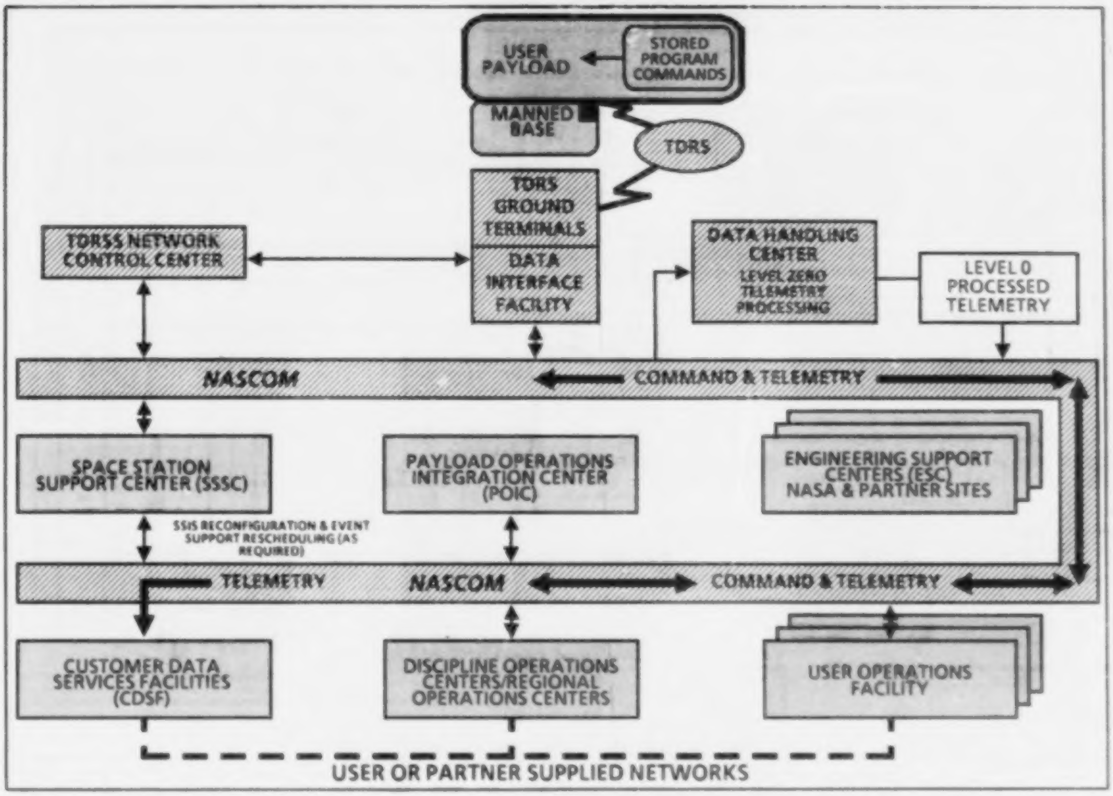
USER PAYLOAD
STORED PROGRAM COMMANDS
MANNED BASE
TDRS
TDRS GROUND TERMINALS
DATA INTERFACE FACILITY
TDRSS NETWORK CONTROL CENTER
DATA HANDLING CENTER
LEVEL ZERO TELEMETRY PROCESSING
LEVEL 0 PROCESSED TELEMETRY
NASCOM
COMMAND & TELEMETRY
SPACE STATION SUPPORT CENTER (SSSC)
PAYLOAD OPERATIONS INTEGRATION CENTER (POIC)
ENGINEERING SUPPORT CENTERS (ESC) NASA & PARTNER SITES
SSIS RECONFIGURATION & EVENT SUPPORT RESCHEDULING (AS REQUIRED)
TELEMETRY
NASCOM
COMMAND & TELEMETRY
CUSTOMER DATA SERVICES FACILITIES (CDSF)
DISCIPLINE OPERATIONS CENTERS/REGIONAL OPERATIONS CENTERS
USER OPERATIONS FACILITY
USER OR PARTNER SUPPLIED NETWORKS

**Figure IV-13 Telescience Operations**

community, the scenarios will be capable of measuring the performance of alternative information system models. The scenarios should include evaluation criteria (e.g., performance, cost, risk, etc.) and support the assessment of end-to-end command, control, and data flow requirements for systems developers, Station users, Station system operators, and operations planners. These results will then be used as a reference baseline against which information systems design and information resource management concepts can be assessed as the Development Phase progresses and as technology evolution studies are conducted.

## Comparison of the Task Force Architecture to the SSIS ADD

As noted earlier, the Task Force SSIS architecture differs from that of the currently baselined SSIS ADD. These differences are in terms of functional capabilities, nomenclature, and locations for various ground-based capabilities. Although there were no differences for the flight elements, the Task Force did make recommendations in several areas (e.g., functional requirements for the onboard OMS mass storage capabilities, the number and size of TDRS antennas, standards and protocols, and the operational use of S-band). Some of these recommendations for the SSIS are contained in Section V of this report. The Space Operations Panel report contains further recommendations for SSIS architecture changes.

Figure IV-14 illustrates the SSIS ADD architecture with the facilities proposed for each site. Figure IV-15 illustrates the modifications recommended by the Task Force. A brief discussion of the major differences and the supporting rationale is provided below. Table IV-3 provides a detailed comparison of these differences.

As proposed by the Task Force, the user interface will be provided by the POIC. In functional terms, the POIC provides services similar to some of the functions provided by the traditional Payload Operations Control Centers (POCC).[20] The POIC will perform user planning, coordination, and conflict resolution functions replacing this portion of POCC activity. The distributed Customer Coordination Center (CCC) and Customer Coordination Nodes (CCN) have also been deleted with their functions assigned to the POIC.

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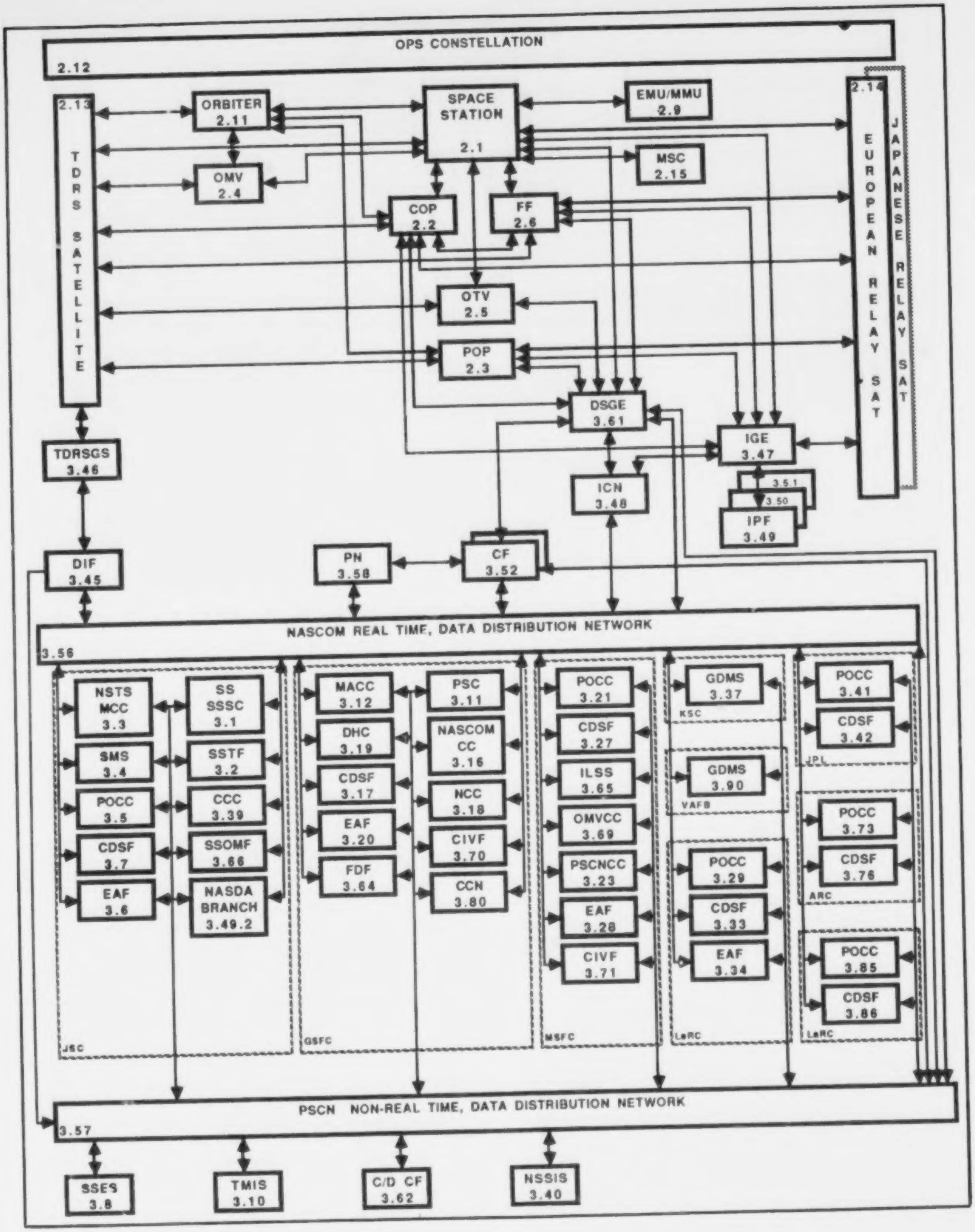
[20] *The POCC is a user facility responsible for planning and conducting payload operations on specific spacecraft. (E.g., each unmanned scientific satellite has a POCC as does each Spacelab mission.)*


OPS CONSTELLATION
2.12
2.13
T D R S SATELLITE
ORBITER 2.11
OMV 2.4
SPACE STATION 2.1
EMU/MMU 2.9
MSC 2.15
COP 2.2
FF 2.6
OTV 2.5
POP 2.3
2.14
EUROPEAN RELAY SAT
JAPANESE RELAY SAT
DSGE 3.61
IGE 3.47
ICN 3.48
3.51
3.50
IPF 3.49
TDRSGS 3.46
DIF 3.45
PN 3.58
CF 3.52
NASCOM REAL TIME, DATA DISTRIBUTION NETWORK
3.56
NSTS MCC 3.3
SS SSSC 3.1
SMS 3.4
SSTF 3.2
POCC 3.5
CCC 3.39
CDSF 3.7
SSOMF 3.66
EAF 3.6
NASDA BRANCH 3.49.2
JSC
MACC 3.12
PSC 3.11
DHC 3.19
NASCOM CC 3.16
CDSF 3.17
NCC 3.18
EAF 3.20
CIVF 3.70
FDF 3.64
CCN 3.80
GSFC
POCC 3.21
CDSF 3.27
ILSS 3.65
OMVCC 3.69
PSCNCC 3.23
EAF 3.28
CIVF 3.71
MSFC
GDMS 3.37
KSC
GDMS 3.90
VAFB
POCC 3.29
CDSF 3.33
EAF 3.34
LaRC
POCC 3.41
CDSF 3.42
JPL
POCC 3.73
CDSF 3.76
ARC
POCC 3.85
CDSF 3.86
LeRC
PSCN NON-REAL TIME, DATA DISTRIBUTION NETWORK
3.57
SSES 3.8
TMIS 3.10
C/D CF 3.62
NSSIS 3.40

SOURCE:
SSIS Architecture Definition Document (JSC 30225)

Figure IV-14 SSIS ADD Architecture

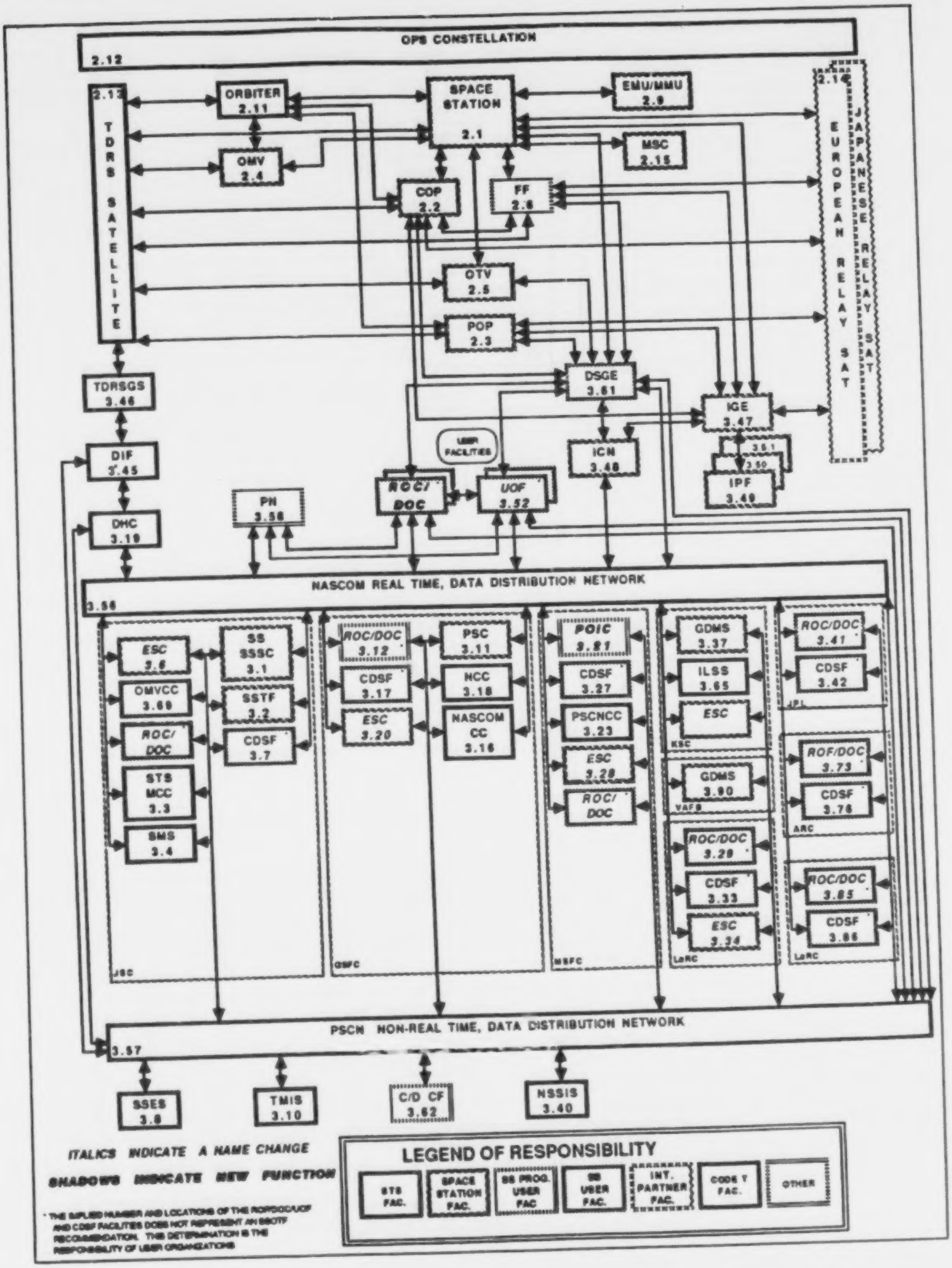

OPS CONSTELLATION
2.12
2.13
TDRS SATELLITE
ORBITER 2.11
OMV 2.4
SPACE STATION 2.1
EMU/MMU 2.9
MSC 2.15
COP 2.2
FF 2.6
OTV 2.5
POP 2.3
2.14
EUROPEAN RELAY SAT
JAPANESE RELAY SAT
DSGE 3.61
IGE 3.47
ICN 3.48
3.51
3.50
IPF 3.49
USER FACILITIES
ROC/ DOC
UOF 3.52
PN 3.58
TDRSGS 3.46
DIF 3.45
DHC 3.19
NASCOM REAL TIME, DATA DISTRIBUTION NETWORK
3.56
ESC 3.6
SS SSSC 3.1
OMVCC 3.69
SSTF 3.2
ROC/ DOC
CDSF 3.7
STS MCC 3.3
SMS 3.4
JSC
ROC/DOC 3.12
PSC 3.11
CDSF 3.17
NCC 3.18
ESC 3.20
NASCOM CC 3.16
GSFC
POIC 3.21
CDSF 3.27
PSCNCC 3.23
ESC 3.28
ROC/ DOC
MSFC
GDMS 3.37
ILSS 3.65
ESC
KSC
GDMS 3.90
VAFB
ROC/DOC 3.29
CDSF 3.33
ESC 3.34
LeRC
ROC/DOC 3.41
CDSF 3.42
JPL
ROF/DOC 3.73
CDSF 3.76
ARC
ROC/DOC 3.85
CDSF 3.86
LaRC
PSCN NON-REAL TIME, DATA DISTRIBUTION NETWORK
3.57
SSES 3.8
TMIS 3.10
C/D CF 3.62
NSSIS 3.40
ITALICS INDICATE A NAME CHANGE
SHADOWS INDICATE NEW FUNCTION
* THE IMPLIED NUMBER AND LOCATIONS OF THE ROF/DOC/UOF AND CDSF FACILITIES DOES NOT REPRESENT AN SSOTF RECOMMENDATION. THIS DETERMINATION IS THE RESPONSIBILITY OF USER ORGANIZATIONS
LEGEND OF RESPONSIBILITY
STS FAC.
SPACE STATION FAC.
SS PROG. USER FAC
SS USER FAC.
INT. PARTNER FAC.
CODE T FAC.
OTHER

Figure IV-15 SSOTF Recommendations To SSIS ADD Architecture

| SSIS ARCHITECTURE DEFINITION DOCUMENT: GROUND ELEMENTS | SSOTF RECOMMENDATIONS |
|---|---|
| DATA INTERFACE FACILITY (DIF) | EXPANDED FUNCTIONS - DIF AT WHITE SANDS (CODE T FUNDS) |
| TDRSS GROUND STATIONS | NO CHANGE - AT WHITE SANDS (CODE T FUNDS) |
| INTERNATIONAL GROUND ELEMENT | NO CHANGE - PARTNERS FUND |
| DIRECT SUPPORT GROUND ELEMENT | NO CHANGE - TBD |
| SPACE STATION SUPPORT CENTER (SSSC) | NO CHANGE - AT JSC |
| SPACE STATION TRAINING FACILITY (SSTF) | NO CHANGE - AT JSC |
| STS MISSION CONTROL CENTER (STS MCC) | EXISTING AT JSC |
| SHUTTLE MISSION SIMULATOR (SMS) | EXISTING AT JSC |
| JSC PAYLOAD OPERATIONS CONTROL CENTER (JSC POCC) | DELETE - FUNCTIONS TO POIC AND ROC/DOC (USERS) |
| JSC ENGINEERING ANALYSIS FACILITY (JSC EAF) | CHANGE TO ENGINEERING SUPPORT CENTER (ESC) |
| JSC CUSTOMER DATA SERVICES FACILITY (JSC CDSF) | NO CHANGE |
| SOFTWARE SUPPORT ENVIRONMENT (SSE) SYSTEM | NO CHANGE - CODE S FUNDED PROCUREMENT FY87 |
| SPACE STATION OPERATIONS MANAGEMENT FACILITY | DELETE |
| CUSTOMER COORDINATION CENTER (CCC) | DELETE - FUNCTIONS TO POIC |
| PLATFORM SUPPORT CENTER (PSC) | NO CHANGE - AT GSFC |
| DATA HANDLING CENTER (DHC) | EXPANDED FUNCTIONS (CODE T FUNDS) |
| MULTIPLE APPLICATIONS CONTROL CENTER (MACC) | DELETE - MISSION OPS FUNCTION IN PSC, SERVICING IN ESC. USER OPS IN ROC/DOC |
| GSFC EAF | CHANGE TO ENGINEERING SUPPORT CENTER (ESC) |
| GSFC CDSF | NO CHANGE |
| NASCOM CONTROL CENTER | EXISTING AT GSFC |
| (TDRSS) NETWORK CONTROL CENTER (NCC) | EXISTING AT GSFC |
| FLIGHT DYNAMICS FACILITY (FDF) | EXISTING AT GSFC |
| GSFC CUSTOMER INTEGRATION & VERIFICATION FACILITY (GSFC CIVF) | DELETE - PART OF GSFC ESC |
| MSFC POCC | DELETE - FUNCTIONS TO POIC AND ROC/DOC (USERS) |
| MSFC EAF | CHANGE TO ENGINEERING SUPPORT CENTER (ESC) |
| MSFC CDSF | NO CHANGE |
| PROGRAM SUPPORT COMMUNICATIONS NETWORK CONTROL CENTER (PSCN CC) | EXISTING AT MSFC (CODE T FUNDED) |
| OMV CONTROL CENTER (OMV CC) | NO CHANGE - CO-LOCATE WITH SSSC/MCC AT JSC |
| INTEGRATED LOGISTICS SUPPORT SYSTEM (ILSS) | EXPANDED FUNCTIONS - LOCATE AT KSC |
| MSFC CIVF | DELETE |
| LeRC POCC | DELETE - FUNCTIONS TO POIC AND ROC/DOC (USERS) |
| LeRC EAF | CHANGE TO ENGINEERING SUPPORT CENTER (ESC) |
| LeRC CDSF | NO CHANGE |
| GROUND DATA MANAGEMENT SYSTEM (GDMS) | EXISTING AT KSC, PARTIAL AT VAFB |
| JPL POCC | DELETE - FUNCTIONS TO POIC AND ROC/DOC (USERS) |
| JPL CDSF | NO CHANGE |
| ARC POCC | DELETE - FUNCTIONS TO POIC AND ROC/DOC (USERS) |
| ARC CDSF | NO CHANGE |
| LaRC POCC | DELETE - FUNCTIONS TO POIC AND ROC/DOC (USERS) |
| LaRC CDSF | NO CHANGE |
| JEM CONTROL CENTER (JEM CC) | PARTNER RESPONSIBILITY |
| JSC NASDA | TBD - JOINT CODE S AND NASDA FUNDING POSSIBLE |
| ESA INTERNATIONAL PARTNER FACILITIES (ESA IPF's) | PARTNER RESPONSIBILITY |
| MOBILE SERVICING SYSTEM GROUND SUPPORT (MSS GS) | NOT DISCUSSED |
| CANADIAN POCC | PARTNER/USER RESPONSIBILITY |
| CUSTOMER FACILITIES (CFs) | DELETE - REPLACE WITH ROC/DOC/UOF (USERS) |
| CONTRACTOR FACILITIES | TBD - TMIS LINKS WORK PACKAGE CONTRACTORS |
| TMIS | NO CHANGE - CURRENT CODE S PROCUREMENT |
| NON SSIS INFORMATION NETWORKS (NSSIS) | USER/PARTNER RESPONSIBILITY |

**NEW SSIS ELEMENTS FROM SSOTF FRAMEWORK**

1. PAYLOAD OPERATIONS INTEGRATION CENTER (POIC) - LOCATE AT MSFC
2. KSC(VAFB) SPACE STATION PROCESSING FACILITIES (PAYLOAD INTEGRATION AND INTERFACE TEST & VERIFICATION FACILITIES)
3. DISCIPLINE OPS CENTERS (DOC) - USER RESPONSIBILITY
4. REGIONAL OPS CENTERS (ROC) - USER RESPONSIBILITY
5. USER OWNED FACILITY (UOF) - USER RESPONSIBILITY
6. LOGISTICS OPERATIONS CENTER (LOC) - AT KSC
7. TBD SSIS INTERFACES TO "SCIENCE AND TECHNOLOGY CENTERS" TO SUPPORT PAYLOAD/RACK BUILD, TEST, AND VERIFICATION

Table IV-3 Comparison Of SSIS ADD And SSOTF Recommendations

While the Program has taken responsibility for coordinating user activities in the POIC, direct payload operations support is till a user responsibility. These functions are performed in the user-provided DOCs, ROCs, and UOFs. The DOCs, ROCs and UOFs thus replace the Customer Facilities (CF) in the SSIS ADD architecture.

Other functional changes include eliminating the GSFC Multiple Applications Control Center (MACC). User support activities proposed for the MACC are now to be performed in DOCs, ROCs, and UOFs. The Servicing Support Center (SSC), attached payload engineering support, and Flight Telerobotics Servicer (FTS) engineering support functions are moved to the GSFC Engineering Support Center (ESC).

In addition to these overall Task Force recommendations, the Space Operations Panel developed further recommendations on modifications and refinements to the SSIS architecture. The first deals with the data interface capabilities at the TDRS ground terminal site in White Sands, New Mexico. The Space Operations Panel recommended enhancing the Data Interface Facility (DIF) capabilities for data relay, repackaging, format conversion, and data buffering.

This panel also suggested additional operational requirements for the planned Data Handling Center (DHC). The current DHC concept calls for a "no value-added" preprocessing of NASA engineering and science data (commonly referred to as Level Zero Processing). The Space Operations Panel also developed additional requirements in the areas of preprocessing for all manned base, platform, and payload data (including voice and TV/Video), "quick-look" data processing and routing, and a store and forward function for non-critical payload and engineering data. Since both the DIF and DHC are to be funded and managed by NASA's Office of Spaceflight Tracking and Data Systems (OSTDS), the implementation of these recommendations must be studied and mutually agreed upon by the Program and OSTDS.

## IV.J. SPACE STATION MANAGEMENT INFORMATION SYSTEMS

The operations framework proposed by the Task Force features an internationally staffed, integrated operations management team. This team will manage and control the Program from a central operations office at NASA Headquarters. Program execution is distributed to NASA and international partner sites. Implementing the Framework will require strong organizational relationships among the various locations and an equally strong and centrally managed set of information management tools and systems. This section provides an overview of the Space Station Management Information Systems (MIS) functions necessary to support the Recommended Framework.

In providing these support systems, there are three key tasks to be completed before beginning their actual development and implementation. These are: (1) describing the use of the systems (i.e., "what" are the jobs to be performed and "how" are they to be performed?); (2) defining the data and information needed to perform the job (further refinement of "how" jobs are performed which includes identifying sources and destinations of data and information as well as defining the functional capabilities of the systems); and (3) developing and implementing effective information management controls.

The first and second tasks are highly iterative in nature. Completion of these tasks results in a functional description of the jobs, a top-level approach to performing them, and top-level functional requirements for the systems. The third task will be especially challenging for the Program. Given the distributed nature of much of the information, the development of the management controls may be more difficult than development of the systems.

### Database Categories and Uses

This section suggests areas in which MIS is required to support overall Program management. It uses as a starting point the work of the Technical and Management Information System (TMIS) project and the surveys and analyses performed to define the scope of this system.[21] As a result of the TMIS Information Analysis task, 28 top-level, key database categories were developed. These are illustrated in Table IV-4.

A review of this table reveals that the database categories support the majority of the basic operations functions (described earlier in Section III) used by the Task Force to develop the Recommended Framework. However, most require further definition in order to describe the job to be performed in support of the Framework.

For example, Figure III-3 illustrates the Recommended Framework's planning and control hierarchy. Utilizing this as a baseline, a follow-on task to be completed by the Program is the more detailed description of the operations and utilization planning job. Therefore, Item 25 in Table IV-4 (Operations) must have at least four separate operations and utilization planning databases (or at least four separate levels of hierarchical detail) to correspond to the four levels of planning identified by the Task Force. While the Task Force has developed "strawman" tables of contents for the major plans (i.e., the CUP, TOP, FIPs, and execute plans), details of "how" the planning process will be completed are yet to be defined.[22]

In this hierarchy of planning, the tactical level provides a good example of the data exchange that must take place. A key product in the Tactical Operations Plan are the multiple increment manifests

TMIS will provide integrated system capabilities to support 28 major Program technical and management processes identified through the TMIS Project's information analysis tasks. These processes are listed below.

1. BUDGETING
2. PLANNING
3. SCHEDULING/PROJECT MANAGEMENT
4. POLICY DEVELOPMENT
5. PERFORMANCE MEASUREMENT
6. TECHNICAL CONTRACT MANAGEMENT
7. ADMINISTRATIVE CONTRACT MANAGEMENT
8. PROGRAM REVIEW
9. EXTERNAL AFFAIRS
10. INTERNATIONAL RELATIONS
11. CUSTOMER RELATIONS
12. REQUIREMENTS ANALYSIS
13. TECHNICAL ANALYSIS
14. INTERFACE CONTROL
15. COST/FINANCIAL ANALYSIS
16. DESIGN
17. DESIGN REVIEW
18. ACQUISITION
19. ADMINISTRATION
20. IMPLEMENTATION AND INTEGRATION
21. TEST AND VERIFICATION
22. DOCUMENTATION
23. CONFIGURATION MANAGEMENT
24. TRAINING
25. OPERATIONS
26. MAINTENANCE
27. PROTOTYPING
28. INVENTORY MANAGEMENT

**Table IV-4 Space Station - Key Databases**

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[21] *The TMIS is being procured by NASA as a mechanism to support the Program's development and mature operations activities.*

[22] *The detailed contents of many of the Operations Execution Plans will either be derivatives of current STS and unmanned spacecraft operations plans or are in the definition stage. While the Task Force did not specify the contents of these detailed plans, it did suggest several databases (both on orbit and on the ground) which would contribute to development of these plans or would be the repository of plans. See Tables IV-5 and IV-6 in this section.*

for transportation systems, payloads, and logistics cargo. With logistics and transportation systems as primary drivers of the Tactical and Flight Increment Planning processes, the MIS must contain detailed databases containing multi-increment information such as logistics requirements, status of consumables and spares, payload requirements, SR&QA hazards, maintenance schedules, transportation availability, test and integration schedules, top-level and detailed ground processing flows and critical path analyses of the end-to-end logistics and transportation schedules. Additional databases are required to support programmatic activities such as scheduling, budgeting, and configuration control.

Given the complexity of the manifesting process and the numbers of variables involved, it also appears necessary to provide tools based on operations research technologies to enable planners to perform trades among the variables affecting each increment plan. for example, there are finite test and integration capabilities at the launch site. There are also finite storage areas for payloads and cargo either awaiting checkout or those that have completed checkout and are waiting to be integrated into the launch vehicle. Developing optimum schedules for the flow of this material through the launch site facilities is a typical operations research problem. Another example where this type of technology will prove useful is in the management of changes to manifests. For instance, if a manifested payload (with certain mass, volume, and power requirements) cannot be delivered as originally scheduled, what substitute payload(s) can be inserted into that particular launch schedule with the minimum of impact on orbiter processing flows, orbiter and payload Flight Data File preparation activities, Space Station operations, and user operations?

These examples illustrate the iterative nature of defining usage along with describing the types of information necessary to perform the manifesting function. The next step is to define the details of the data, sources and destinations of data and information, and database structures. These must all be completed before database development can begin.

### Potential Databases for Space and Ground Operations

The Task Force identified several potential databases for both orbiting systems and ground systems. These are listed in Tables IV-5 and IV-6 respectively. As can be seen from these candidate lists, there is a wide range of data and information necessary to support the full scope of Program operations. Key among these will be hierarchically consistent data sets of operations performance, cost performance, and program risk

**DATABASES APPLICABLE TO MANNED BASE AND PLATFORM**

- **Payload Characteristics**
  Resource requirements, servicing requirements, constraints, restricted operations
- **Operational Event List**
  Combination of schedule and stored transactions
- **Payload Fault Isolation Data**
  Diagnostic programs, executable procedures, operational procedures
- **Payload/Systems Operational Procedures**
  Nominal and malfunction-executable procedures, operational procedures
- **Application Software Loads**
  Core/system elements, payload elements
- **System Software Loads**
  SDP software, NIU software, MPAC software, display templates
- **Master Schedule**
  Short term
- **Payload Status**
- **Core Subsystem Status**
- **Navigation Data**
  Ephemeris: SS, TDRSS, COP, free-flyers, GPS, OMV, NSTS, platforms
- **Software Configuration Management Data**
- **Hardware Configuration Management Data**
- **Ancillary Data**
  Core and user induced
- **Instrumentation/Measurement List**
  Core and Payload
- **Buffered Recorder Data**
- **Configuration Data**
  Address mapping tables, authorization tables, constraint tables, expendable resource capacity
- **Fault Isolation Rules**
  List of rules, recovery procedures
- **Security/Privacy**
  Commercial, technology transfer

**DATABASES APPLICABLE TO MANNED BASE ONLY**

- **Payload and System Training Procedures/Simulations for Skills Retention**
- **On-orbit Checkout Procedures**
- **Servicing Procedures and Servicing Element Characteristics**
  STS, OMV, OTV, EVA/IVA, MSC, free flyers
- **Crew member Data**
  Medical profiles, confidential/personal, medical facility
- **Safehaven Procedures**
- **Security/Privacy**
  Crew, DOD
- **Master Schedule**
  Long Term
- **Inventory**
  Consumables, spares
- **Payload Fault Isolation Data**
  Description diagram

Table IV-5 Candidate On-Board Databases

**GROUND DATABASES IDENTIFIED IN TMIS RFP**

- Reference Configuration (REFCON)
- Mission Requirements (MRDB)
- Engineering Drawing
- SR & QA Hazards
- SR & QA Safety Requirements Compliance
- Scheduling Database

**OTHER POTENTIAL GROUND DATABASES**

- Operational Procedures
  - Nominal and Malfunction
- Operational Restrictions, Notes, and Wavers
- Payload Manifests
- Systems Operations Timelines
- User Operations Timelines
- Crew Activity Timelines
- Integrated System/User Operations Timelines
- Core and Platform Systems Resource Allocations
- Core and Platform User Resource Allocations
- User/Systems OPS Access Control Tables
- Command Formats
- Predefined Command Sequences
- Event/History Logs/Diagnostic Trials
- Payload/Instrument Configurations
- Onboard Data Channelization Systems and Payloads
- Telemetry Calibration, Data Types and Units
- Master Measurement List
- Systems Monitoring Limit-Sets and Limits
- Ground Systems Configuration Management
  - Hardware and software
- Onboard Systems Configuration Management
  - Hardware and software
- Network Configuration Management
  - Hardware and software
- Logistics Inventory
- Manned Base and Platform Ephemerides
- Ancillary Engineering Analysis Data

Table IV-6 Ground Databases

assessments. Other databases capturing the "design knowledge" of the development Centers and their contractors must also be established and maintained throughout the Development Phase. These data will be used in analyses supporting near-term operations management as well as developing plans for evolution of Station elements.

### Management and Control

While the Recommended Framework calls for Headquarters control, it is important to recognize that the majority of the information necessary for the Headquarters organization to perform its tasks resides at the distributed NASA, partner, and user operations centers. As a result, the Task Force developed recommendation and requirements for Program level management and control but left the details of the day-to-day control of data and database operations to these distributed centers.

One of the most critical requirements to be established by the Program will be the accuracy and timeliness of information contained in the databases. The information in each must be rapidly updated as changes occur. Key relationships among data sets must be established so that planners and operations managers will have immediate notice of and access to changes, regardless of the location of the changes. The relationships must also identify the impact of changes on the overall planning and flight increment management process.

This implies that access to most databases must be available at each of the distributed execution locations as well as at NASA Headquarters. Control over that access and control over changes to the contents of each database resides with the center or office responsible for individual databases. To amplify this point, it should be possible for an authorized user to make a copy of a data set, manipulate the data, and or delete data from the copy, perform analyses, produce reports, etc. However, no user should be permitted to make a permanent change to the data or to the database operating system without approval of the responsible database manager.

Ready access to data and information can be most effectively accomplished through Program-wide definition of database standards. It is essential to define common data types and characteristics. However, dissimilar database architectures may be used to support specialized functions if the data characteristics are preserved across interfaces and translations among databases. Thus, the design goal for SSP databases should be to ensure commonality and uniformity of data sets, units of measure, and representation formats (both data content and level of detail) without constraining programming languages and user interfaces. This will be particularly important as the Program seeks to achieve interoperability among the operational SSIS, TMIS, SSE, and other existing data and information systems.

As noted in the introduction to this section, TMIS and other systems such SSE, can provide some of the tools and connecting systems necessary to perform the task, but it will be the responsibility of the various Program and Center organizations to actually develop the databases, enter the data, and perform database maintenance and control. The Program will also have to develop special tools, such as the operations research tools mentioned above, independent of TMIS and the Phase C/D Work Package contracts.

# V. RECOMMENDATIONS FOR IMPLEMENTATION

The following list comprises the official recommendations of the SSOTF. They fall within five broad categories: (1) Program Operations Management Recommendations; (2) Space Operations and Support Recommendations; (3) User Integration and Accommodation Recommendations; (4) Logistics Operations Support Recommendations; and (5) Systems Development Recommendations. The first four categories contain recommendations pertaining to implementation of the operations framework as described in this Summary Report; the fifth category contains several systems "design-to" type recommendations derived from the individual panel reports and are fully supported by the SSOTF.

Additional panel recommendations pertaining to the detailed implementation of the various operational issues addressed during the term of the SSOTF may be found within the individual Panel Reports. Implementation of these detailed recommendations should be the prerogative of the appropriate operations support organizations once the overall Station Operations Organization is established.

## V.A. PROGRAM OPERATIONS MANAGEMENT

1. Immediately baseline the Space Station operations framework as described in this SSOTF Summary Report. Appropriately revise existing Program documentation to reflect this baseline.

2. Implement the Station operations management organization structures for the Development and Mature Operations Program phases as detailed by the SSOTF Summary Report (reference Figures III-26 and III-25, respectively), including the following highlights:

   A. Separate utilization and operations organizational and budgetary functions from space systems development and budgetary functions at the Program Integration level for transition, and the Associate Administrator level for mature operations

   B. Establish the Office of Director, Utilization and Operations at the Program Integration Level.

   C. For mature operations, provide an Increment Change Management Office at the Program Integration Level to manage all aspects of preflight planning with the delegated authority of the Director, Utilization and Operations.

   D. Identify the organizational elements as well as the Program control and support responsibilities at each management level. At the Program Execution level, allow implementation flexibility with regard to project vs. matrix support structure.

3. Implement the following NASA support center functional assignments:

   A. Program integration and control: NASA Headquarters.

   B. For the manned base, user operations focus, including the integration of user operations and servicing requirements and plans: the Marshall Space Flight Center (MSFC).

   C. For the manned base, space systems operations focus, including the integration of space systems operations requirements with KSC-provided ORU maintenance requirements and MSFC-provided user operations and servicing requirements into executable and safe plans and procedures: the Johnson Space Center (JSC).

   D. For the manned base and platforms, integration of logistics operations support requirements and plans: the Kennedy Space Center (KSC).

   E. For the U.S. platforms, integration of all space and user systems requirements and plans: the Goddard Space Flight Center (GSFC).

   F. For the manned base and platforms, provision of sustaining engineering for the orbiting elements and systems: the Lewis Research Center (LeRC), MSFC, JSC, GSFC and KSC as appropriate to Program responsibilities for element and systems development.

4. Develop specific implementation requirements, plans and schedules for the ground facilities which the SSOTF recommends for Space Station operations support, to include:

   A. Construction of a phasing plan that identifies those facilities which are mandatory to support first element launch and those whose readiness may be phased in to support subsequent assembly operations.

   B. Identification of requirements, if any, for those facilities which the SSOTF identified as questionable.

   C. Inputs to the construction of facility (C of F) process including schedules and priority assignments.

   D. Development of a cost-sharing approach between the STS and Space Station Programs for those facilities which are shared.

   E. Identification of those Station Program facilities built to support the Development Phase of the Program which will be required to support ongoing sustaining engineering operations.

5. Establish and document the Program configuration control processes at each organizational level as required to implement this SSOTF Operations Framework. Further develop the content, scope and framework for the Consolidated Utilization Plan, the Tactical Operations Plan, and the Flight Increment Plans, and determine specific organizational responsibilities, interface protocols, information systems requirements and schedules for their production and review.

6. To facilitate Program operations life cycle cost projections:

   A. Conduct an operations costs estimation study with each participating operations organization using the center assignments, facility requirements and overall operations framework described in this Summary Report.

   B. Develop a process for estimating annual operations costs which accounts for all elements of the operational framework as described within this Summary Report.

7. Ensure that the Program Integration level (NASA Headquarters) of the Station Operations organization retains control of the overall SSIS architecture, including SSIS interface with both the TMIS and SSE operational support systems. This includes control of all requirements affecting the various nodes of the SSIS network. Further, to ensure SSIS interface compatibility with user telescience requirements, a user telescience scenario should be developed by the Program as a reference against which SSIS capabilities can be assessed and technology trades conducted.

8. The SSOTF emphasizes the need for development of a TMIS that fully supports all aspects of this operations framework during each Program phase. The technical and political difficulty of achieving present and future interoperability between NASA and partner operations support centers, and between the Space Station and STS Programs, represents a significant Program challenge which must receive the early and continued attention of top NASA management. Crucial to the success of such an effort is the early identification of the various Program databases (engineering and operations) required to support the Program's Development Phase; these databases will serve as the point of reference for each organizational level as the Program transitions to the Mature Operations Phase.

9. Develop an equitable policy regarding sharing of operations costs among the partners. This policy must be straightforward and easily implemented and should consider individual partner resource allocations, sustaining engineering responsibilities, and overall contributions to routine Station operations.

10. Develop an equitable pricing policy for utilization of Station resources. This policy must be straight forward and easily implemented and should cover the variety of anticipated government and non-government users of the Station, both domestic and foreign.

11. Upon joint approval of the NASA/partner MOUs regarding international cooperation in the Space Station Program development and operations phases, immediately begin to integrate international participation at all levels of the operations organization.

12. Establish an operations performance assessment system available to each level of Program management which identifies symptoms of non-optimal performance as well as decision path alternatives which, if implemented, could improve ground and onboard operations effectiveness.

## V.B. SPACE OPERATIONS AND SUPPORT

13. Baseline the following criteria relative to flight crew composition and skills emphasis:

    A. The Director, Utilization and Operations, shall have final approval authority for selection of all manned base crew members.

    B. The manned base shall have a commander who is a NASA career astronaut.

    C. Manned base crew members shall be assigned, trained and integrated on board as an integrated team.

    D. Scientific credentials shall be considered paramount when selecting candidates for Station Scientist positions.

14. Immediately establish a multicenter/ multinational Training Coordination Board to integrate advanced planning activities associated with the use of all crew training facilities supporting the Space Station Program.

15. U.S. and ESA Platform operations planning should be the sole responsibility of the sponsoring partner below the Program Policy (strategic planning) level. Further, the platforms should operate independent of each other and of the manned base, except for proximity servicing operations of co-orbiting platforms at the manned base.

16. Ensure that there is a full backup capability to the Station ground command and control network to cover environmental and technical contingencies affecting routine Station operations.

17. The Program should develop a single element loss and recovery program plan applicable to the assembly phase.

## V.C. USER INTEGRATION AND ACCOMMODATION

18. Establish an independent (external to the Station Operations organization) U.S. Space Station User Board (SSUB), reporting to the NASA Adminis-

trator and supporting the Associate Administrator for Space Station Operations in strategic planning for Station utilization. Membership on the SSUB should be at the Associate Administrator (or equivalent) level as determined by the NASA Administrator, and responsibility for chairmanship should rotate annually among member organizations. Additionally:

A. Develop NASA policy for the SSUB charter including specific protocols for its interface with the Space Station Program.

B. Encourage each international partner to establish an analogous user board with similar functions and protocols for interface with the Space Station Operations organization.

C. Establish the SSUB process for allocating U.S. and partner resources to the various Station user sponsors.

19. To facilitate user accommodation and integration within the Program, provide a cadre of Payload Accommodation Managers (PAMs) accountable to the Program Integration level (NASA Headquarters) of the Operations organization. Each PAM will be a senior utilization and operations advocate who will serve as the primary liaison between each selected user, the Station and the appropriate transportation system program.

## V.D. LOGISTICS OPERATIONS SUPPORT

20. As a means of reducing Station dependency on the STS:

A. Provide an independent means of Station crew recovery which satisfies Program requirements for accommodating on-board medical contingencies as well as for rescue of the total Station crew.

B. Provide an independent means of logistics support to the Station. Study the feasibility of the following as potential "design solutions":

-- Independent cargo return: STS-launched logistics carrier with either a recoverable ballistic or a controlled atmospheric destruction reentry capability;

-- Independent cargo resupply and return: ELV launched logistics carrier with an auto rendezvous and/or OMV retrieval capability, and either a recoverable ballistic or a controlled atmospheric destruction reentry capability.

C. Perform cost trades on "throwaway" versus STS-serviceable polar platforms.

D. Perform cost trades on standard versus nonstandard ORU and payload interfaces for STS and ELV launch vehicles.

21. Establish a distributed approach to payload integration which allows:

A. Payload-to-rack and payload-to-PIA integration and functional operations verification at Program-designated NASA and partner Science and Technology Centers.

B. Rack-to-element integration and interface verification at the launch site.

C. Integrated operations end-to-end checks on-orbit.

22. Initially establish a distributed approach to space systems sustaining engineering which allows:

A. Space systems sustaining engineering performed by appropriate NASA and partner development centers as defined in Table III-7. (For the U.S., this represents the Development Phase work package assignments.)

B. NASA Headquarters coordination at the Program Integration level.

C. Gradual centralization of U.S. orbiting elements sustaining engineering functions at KSC, commensurate with Program management determination that the corresponding space systems have reached their performance maturity.

## V.E. SYSTEMS DEVELOPMENT

23. Add a second Ku-band system on the manned base as a backup to normal operations and to enhance operability by minimizing TDRS hand-over dropout.

24. Increase Ku-band antenna size or radiation power to accommodate full forward link TDRS bandwidth of 25 mbps, or provide effective TV compression techniques within the available reduced bandwidth.

25. Provide for operational use of S-band and consider assignment of critical manned base systems and crew operations functions to this band. This would provide for interoperability with international relay satellites and improve partner communication links.

26. Conduct trade studies to establish the potential for ground-based operators and users to have "continuous acquisition of signal" with the Station's manned base.

27. As a means of facilitating evolutionary orbital operations, develop the following additional capabilities which are beyond current baselines:

A. Increase allowable crew stay time through development and implementation of a medical flight duration extension program.

B. Expand the on-board environmental monitoring capability and electronically link to the manned base Health Maintenance Facility. The system should be capable of quantifying biohazards and microbial loads.

C. Investigate methods of safely increasing STS passenger capacity.

28. The Program should provide additional racks as required to support the distributed payload integration concept; the number of currently baselined racks appears to be insufficient. Additionally, rack and PIA level simulators should be provided to each Science and Technology Center to facilitate standardized payload-to-rack and PIA integration and verification.

29. Provide a capability for late pad access to logistics module pressurized volume (e.g., side hatch, access port).

30. To the maximum extent possible, the Station Development Program should achieve space systems "fit and function" commonality across all Station elements. Commonality is an effective means of reducing the operational complexity of performing Station logistics and on-orbit housekeeping tasks, thereby increasing potential for user accommodation. Commonality criteria should be developed early in the Development Phase of the Program and, subsequently, be formally controlled at the Program Integration level.

# APPENDIX A

# APPENDIX A

## SSOTF Composition and Background Briefings

The following material presents the complete listing of members, participants and supporting consultants in the Space Station Operations Task Force. The SSOTF membership was divided into four panels, chaired by panel leaders, each with an area of specific emphasis. The four panels were: (1) Space Operations and Support Systems; (2) Ground Operations and Support Systems; (3) User Development and Integration; and (4) Management Integration. Space Operations incorporated all operational components of the Program which provide the planning, training, and operational management for the conduct of on-orbit activities. Ground Operations encompassed all components of the Program which provide the planning, engineering and operational management for the conduct of integrated logistics support (logistics, sustaining engineering, pre/post-launch processing and transportation services). User Development encompassed all areas of the Program related to user accommodation and integration activities (marketing, manifesting, user selection and pricing). Management Integration included all SSOTF internal concept integration and analysis coordination (methodology development, operations functions definitions and scenario generation) required to provide an integrated operations framework.

In addition to the NASA members on these panels, a number of external participants supported the SSOTF in varying degrees. These included members of industry, NASA Center Directors and key Headquarters personnel, and participants from outside NASA (Air Force SR-71 Program, U.S. Navy Trident Submarine Program, and British Navy Submarine Operations). A number of firms also briefed the Task Force on various aspects of operations. Finally, the SSOTF employed support contractors to aid in the report preparation and integration activity. All these participants and their contributions are listed on the following pages.

## PANEL MEMBERSHIP

| PANEL 1 Space Operations and Support Systems | | PANEL 2 Ground Operations and Support Systems | | PANEL 3 User Development and Integration | | PANEL 4 Management Integration | |
|---|---|---|---|---|---|---|---|
| *John T. Cox | JSC | *Charles Mars | KSC | *George Anikis | HQ/MC | *Granville Paules | HQ/SO |
| Anne L. Accola | JSC | Judy Anderson | KSC/VAFB | Laura Crary | JPL | Kevin P. Barquinero | HQ/S |
| Lawrence S. Bourgeois | JSC | Barbara Arnold | DoD/OASD | William Gray | JPL | Daniel A. Bland | JSC |
| Robert L. Bowman | LeRC | Dick Bohlmann | KSC | Carolyn Kimball | HQ/S | Karen Brender | LaRC |
| Walter Bradley | GSFC | Charles Bunnell | MSFC | Deborah Langan | JSC | Johanna A. Gunderson | JSC |
| Robert S. Clark | JSC | Bonnie P. Dalton | ARC | Lisa Mann | ARC | Joseph Joyce | LeRC |
| Romo Cortez | HQ-T | John Ewashinka | LeRC | Larry Milov | ARC | Douglass Lee | DOT |
| Anthony W. England | JSC | James Kelley | KSC | John Mitchell | JSC | Richard O'Toole | JPL |
| Carolyn S. Griner | MSFC | Kam Kersey | KSC | Dave Porter | JPL | William Pegram | HQ/SU |
| Mike Hawes | JSC | John McBrearty | KSC | William Roberts | MSFC | Robert Shishko | JPL |
| Frank E. Hughes | JSC | Roland (Mack) McCartney | KSC | Jeff L. Smith | JPL | Gregory Williams | HQ/SO |
| Richard Koos | JSC | Robert J. Manly | LeRC | Olav (Ole) Smistad | JSC | | |
| Richard Laeser | JPL | Jim Mizell | KSC | Nicholas Talluto | KSC | | |
| Charles M. Lewis | MSFC | James W. Moore | MSFC | Richard Tyson | OAST/LaRC | | |
| James S. Logan | JSC | Danny F. Nail | KSC | Don West | GSFC | | |
| Edward Lowe | GSFC | Eugene Nelson | KSC | | | | |
| Axel Roth | MSFC | Rick Nelson | DoD/USAF | | | | |
| William C. Webb | GSFC | Raymond L. Norman, Jr. | KSC | | | | |
| R. B. (Pete) Williams | JSC | Christian Poulsen | KSC | | | | |
| | | Kal S. Purushotham | MSFC | | | | |
| | | Haley Rushing | KSC | | | | |
| | | David H. Suddeth | GSFC | | | | |
| | | Libby Wells | KSC | | | | |
| | | Lynn Wolard | DoD/USAF | | | | |

* Leader

# PANEL MEMBERSHIP
# (Continued)
# ASSOCIATE MEMBERS

| PANEL 1 Space Operations and Support Systems | | PANEL 2 Ground Operations and Support Systems | | PANEL 3 User Development and Integration | | PANEL 4 Management Integration | |
|---|---|---|---|---|---|---|---|
| Kathleen Abotteen | JSC | Steve Alexander | LeRC | Harry Atkins | MSFC | Katherine R. Daues | JSC |
| Bob Brotherton | GSFC | Richard Baldwin | GSFC | Susan (Stacy) Edgington | HQ/I | Donald Eide | HQ/SO |
| Jack Bullman | MSFC | Charles Baugher | MSFC | Walt Feitshans | KSC | Paul Heartquist | DoD/USAF |
| Rick Chappell | MSFC | Stanley Blackmer | JSC | F. Michael Goeser | HQ/MC | Harold Miller | HQ/SO |
| Tony Comberiate | GSFC | Lloyd Chamberlin | KSC | Ben Higbie | DoD/USAF | James Robinson | HQ/SO |
| Denis Dahms | JSC | Robert R. Corban | LeRC | Bryant J. Keith | HQ-M | Robert J. Soltess | HQ-S |
| Charles Elachi | JPL | William Galoway | MSFC | Richard Ott | HQ-M | Mike Stevens | HQ/T |
| Jerome B. Hammack | JSC | Guy Gardner | JSC | Thomas Overton | KSC | Guilio Varsi | HQ/S |
| Adrian Hooke | JPL | Charles E. Howard | JSC | Lowell Primm | HQ/MC | | |
| Bill Kilpatrick | MSFC | Gary Johnson | MSFC | Donna A. Shortz | HQ/S | | |
| Kristan Lattu | JPL | Gerald P. Kenney | JSC | John R. Yadvish | HQ/I | | |
| Roy C. Lester | MSFC | Harold A. Loden | JSC | | | | |
| Daryl Rasmussen | ARC | Joe L. Lusk | MSFC | | | | |
| Jack Schwartz | JPL | James F. McGuire | HQ/S | | | | |
| Taylor Wang | JPL | Herman Mobley | JSC | | | | |
| Jerry Weiler | MSFC | Gregory A. Opresko | KSC | | | | |
| Bob Williams | JSC | William H. Oyler | KSC | | | | |
| Michael Wortham | DoD/USAF | Glenn R. Parker | KSC | | | | |
| | | David Tipton | KSC | | | | |
| | | Dennis Vander Tuig | GSFC | | | | |
| | | Emeterio Zarraonandia | KSC | | | | |

# PANEL MEMBERSHIP
# (Continued)
# MEMBERS AT LARGE

| | |
|---|---|
| James F. Buchli | JSC |
| Philip Cressy | GSFC |
| Michael Devirian | HQ-E |
| Kenneth Frost | GSFC |
| Ronald H. Gerlach | JSC |
| Adam Gruen | HQ-LBH |
| David C. Leestma | JSC |
| Michael C. McEwen | JSC |
| Remer Prince | HQ-SU |
| Erwin Schmerling | HQ-E |
| Ray Sizemore | LeRC |
| Marsha Torr | MSFC |

# SPACE STATION OPERATIONS TASK FORCE SPECIAL CONSULTANTS

| NAME | ORGANIZATION | PANEL NO. |
|---|---|---|
| Joe Allen | Space Industries Inc. | 3 |
| Herbert Bartlett | Aeroflex | 2 |
| William E. Brooks | Booz, Allen and Hamilton | 4 |
| Randy Davis | U of Colorado | 1 |
| John Egan | The Egan Group | 3 |
| Robert T. Everline | Consultant | 3 |
| Dennis Fielder | TADCORPS | 4 |
| Owen Garriot | Consultant | 1 |
| David Greulich | Cabot Corp | 3 |
| John Hunsucker | University of Houston | 4 |
| James T. Kaidy | Booz, Allen and Hamilton | 4 |
| Bill Lenoir | Booz, Allen and Hamilton | 4 |
| Bryon Lichtenberg | PSI | 1 |
| James Moore | Consultant | 2 |
| Henry J. Pierce | Booz, Allen and Hamilton | 4 |
| Chris Podsiadly | 3M Company | 3 |
| Mark Oderman | CSP Associates, Inc. | 4 |
| George Schmidt | Booz, Allen and Hamilton | 4 |
| Rebecca Simmons | CSP Associates, Inc. | 4 |
| Ed Sofinowski | Consultant | 1 |
| Marc Vaucher | CSP Associates, Inc. | 4 |
| Charles Walker | McDonnell Douglas Astronautics Co. | 3 |
| Charles Williams | Earth Observation Satellite Co. | 3 |
| Michael Wiskerchen, Jr. | Stanford University | 3 |
| Donald York | University of Chicago | 3 |

## SOME OTHER CONTACTS

- **Center Directors**
- **Other Associate Administrators**
- **Past Program Directors**
  - **Charles Mathews**
  - **William Schneider**
  - **Leland Belew**
- **Projects/Programs**
  - **SR 71**
  - **Trident Submarine**
  - **British Navy Submarine Operations**

# BACKGROUND BRIEFINGS COMPLETED

| | |
|---|---|
| SSOTF Special Directions | A. Stofan |
| What is a Space Station | T. Finn |
| Background and Status of Agreements with Internationals | G. Rice/M. J. Smith |
| Space Station Baseline Configuration | T. Bonner |
| Space Station Evolution Configuration | D. Black |
| Development Program Management | J. Aaron |
| Space Station Budget Perspectives | J. Sheahan/D. Bates |
| Columbia Lakes Operations Symposium Review | C. Mathews |
| Integration Assembly and Checkout | H. Benson |
| Characteristics of R&D vs. Operations Organization | J. Hunsucker |
| Pricing Policy Overview | J. Smith |
| Space Station Information Systems (SSIS) | D. Hall |
| Technical and Management Information Systems (TMIS) | C. Harlan |
| KSC Operations Lessons Learned | J. Ragusa |
| Congressional Perspectives | M. D. Kerwin |
| SS Work Breakdown Structure | W. Whittington |
| Commercial Operations | Coopers-Lybrand/J. Egan |
| Space Policy | CSP/M. Vaucher |
| Soviet Space Station | DoD and B. J. Bluth |
| Program Logic | W. Whittington |
| Automation and Robotics | G. Varsi |
| Astrophysics | F. Martin |
| Lessons Learned From Other Programs | Skylab, Spacelab, et al. |

## OPERATIONS TASK FORCE INDUSTRY EXCHANGE LIST

ABEX CORPORATION
AEROJET TECH SYSTEMS CO.
AIR PRODUCTS & CHEMICALS INC.
ALCOA TECHNICAL CENTER
ALLIS CHALMERS CORPORATION
AMERICAN CYANAMID
ARMCO, INC.
ASARCO, INC.
ASHLAND CHEMICAL COMPANY
ATLANTIC RICHFIELD CO. - ARCO
AT&T BELL LABORATORIES
***BALL AEROSPACE SYSTEMS DIVISION***
BECTON-DICKINSON COMPANY
BELL COMMUNICATIONS RESEARCH
***BOEING***
BORG-WARNER CORPORATION
BOOZ, ALLEN AND HAMILTON
BRUNSWICK CORPORATION
CACI
CAMUS, INC.
CSP ASSOCIATES, INC.
***COMPUTER SCIENCES CORPORATION***
COMBUSTION ENGINEERING INC.
COMARCO
COMSIS
CORNING GLASS WORKS
CUMMINS ENGINE COMPANY
***LOCKHEED MISSILE & SPACE COMPANY***
LTV-VOUGHT CO.
MARTIN MARIETTA
MECHANICAL TECHNOLOGY, INC.
***McDONNELL DOUGLAS***
McDONNELL DOUGLAS TECHNICAL SERVICES CO.
NASA SOUTHERN TECHNOLOGY APPLICATION CENTER (STAC)
NORTON COMPANY
OAO CORPORATION
OWENS - CORNING FIBERGLASS CORPORATION
***PACE AND WAITE, INC.***
PERKIN-ELMER
PHILLIPS PETROLEUM
PRIME WELDING SYSTEMS
P.R. MILLER ASSOCIATES
RCA
REMOTE MANIPULATOR SYSTEMS DIVISION
ROCKETDYNE
ROCKET RESEARCH CO.
***ROCKWELL INTERNATIONAL***
SCHERING-PLOUGH CORPORATION
SPACE COMMUNICATIONS CO.
SPAR AEROSPACE
SPERRY FLIGHT SYSTEMS

DARTCO
EAGLE ENGINEERING
ESSEX CORPORATION
EXXON RESEARCH & ENGINEERING COMPANY
FAIRCHILD REPUBLIC CO.
FLEXWATT CORP.
FORD AEROSPACE & COMMUNICATIONS CORPORATION
GARRETT CORPORATION
GARRETT FLUID SYSTEMS COMPANY
GARRETT PNEUMATIC SYSTEMS DIVISION
GENERAL DYNAMICS-SPACE SYSTEMS DIV.
***GENERAL ELECTRIC***
GRUMMAN
HARRIS CORPORATION
HERCULES, INC.
HONEYWELL INC.
HUGHES AIRCRAFT CO.
***IBM***
INTEL CORPORATION
INTEGRATED SYSTEMS ANALYSIS, INC.
INTERMETRICS INCORPORATED
J.M. HUBER COMPANY
KAMAN SCIENCES CORP.
LIFE SYSTEMS, INC.

STARK & STROBEL ASSOCIATES
STAR TECHNOLOGY AND SCIENCE
SUNDSTRAND MISSILE & SPACE POWERS SYSTEMS
TELEDYNE BROWN ENGINEERING
TELEPHONICS CORPORATION
TEXACO, INC.
THERMACORE, INC.
THUR ENGINEERING AND MANAGEMENT, INC.
***TRW SPACE AND TECHNOLOGY GROUP***
UMPQUA RESEARCH CO.
UNION CARBIDE CORPORATION
***UNITED AIRLINES***
UNITED STATES GYPSUM COMPANY
UNITED TECHNOLOGIES CORP.
UNITED TECHNOLOGIES POWER SYSTEMS (UTC)
VITRO CORPORATION
WESTINGHOUSE ELECTRIC
WHIRLPOOL CORPORATION
***WYLE LABORATORIES***
XEROX CORPORATION

Bold means Briefed Task Force

# APPENDIX B

# APPENDIX B

## KEY OPERATIONS FUNCTIONS

The SSOTF Recommended (operations) Framework was developed using the following basic approach:

- Development of a functional description of the operations job (the "what").
- Development of a description and illustration of the Recommended Framework (the "how") along with a discussion of key options considered.
- Development of a description and illustration of the recommended mature operations organization performing the functions within the context of the Recommended Framework.

The purpose of this Appendix is to elaborate upon the operations functions developed by the SSOTF. These functions establish the basis for discussion of the Recommended Framework in various areas of operations.

### 1. FUNCTIONAL CATEGORIES

Viewed top-down, the jobs to be performed for planning and conducting operations on the manned base and the platforms fall naturally into three basic categories: Program Policies, those activities managed by the Space Station Program which affect both Station and user operations; User Operations, those activities for which the user community is responsible; and Space Station Program Operations, those activities for which the International organizations supporting the Space Station are responsible. Exhibit 1 illustrates these categories.

The summary categories illustrated in Exhibit 1 reflect a much more detailed functional analysis performed by the SSOTF. The brief sections below provide an overview of this process and illustrate in more detail the functional areas defined and analyzed by the SSOTF in developing the Recommended Framework.

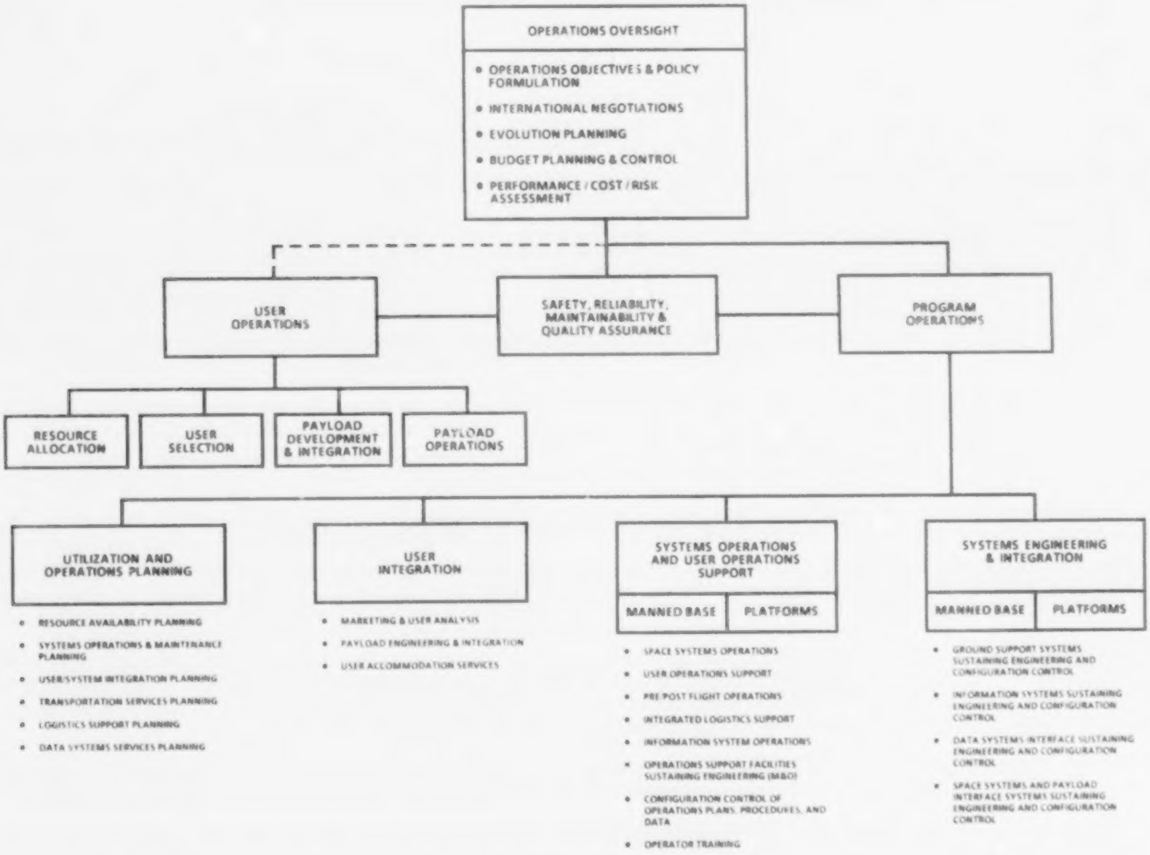

OPERATIONS OVERSIGHT
• OPERATIONS OBJECTIVES & POLICY FORMULATION
• INTERNATIONAL NEGOTIATIONS
• EVOLUTION PLANNING
• BUDGET PLANNING & CONTROL
• PERFORMANCE / COST / RISK ASSESSMENT
USER OPERATIONS
SAFETY, RELIABILITY, MAINTAINABILITY & QUALITY ASSURANCE
PROGRAM OPERATIONS
RESOURCE ALLOCATION
USER SELECTION
PAYLOAD DEVELOPMENT & INTEGRATION
PAYLOAD OPERATIONS
UTILIZATION AND OPERATIONS PLANNING
• RESOURCE AVAILABILITY PLANNING
• SYSTEMS OPERATIONS & MAINTENANCE PLANNING
• USER/SYSTEM INTEGRATION PLANNING
• TRANSPORTATION SERVICES PLANNING
• LOGISTICS SUPPORT PLANNING
• DATA SYSTEMS SERVICES PLANNING
USER INTEGRATION
• MARKETING & USER ANALYSIS
• PAYLOAD ENGINEERING & INTEGRATION
• USER ACCOMMODATION SERVICES
SYSTEMS OPERATIONS AND USER OPERATIONS SUPPORT
MANNED BASE
PLATFORMS
• SPACE SYSTEMS OPERATIONS
• USER OPERATIONS SUPPORT
• PRE/POST FLIGHT OPERATIONS
• INTEGRATED LOGISTICS SUPPORT
• INFORMATION SYSTEM OPERATIONS
• OPERATIONS SUPPORT FACILITIES SUSTAINING ENGINEERING (M&O)
• CONFIGURATION CONTROL OF OPERATIONS PLANS, PROCEDURES, AND DATA
• OPERATOR TRAINING
SYSTEMS ENGINEERING & INTEGRATION
MANNED BASE
PLATFORMS
• GROUND SUPPORT SYSTEMS SUSTAINING ENGINEERING AND CONFIGURATION CONTROL
• INFORMATION SYSTEMS SUSTAINING ENGINEERING AND CONFIGURATION CONTROL
• DATA SYSTEMS INTERFACE SUSTAINING ENGINEERING AND CONFIGURATION CONTROL
• SPACE SYSTEMS AND PAYLOAD INTERFACE SYSTEMS SUSTAINING ENGINEERING AND CONFIGURATION CONTROL

EXHIBIT-I OPERATIONS FUNCTIONS

## 2. FUNCTIONAL HIERARCHY

The process of developing alternative operations frameworks for the manned Space Station and the Platforms began with defining the top-level operations activities in functional terms. Exhibit 2 illustrates the top-level functional flow at three levels; Program Policy, Program Integration, and Program Execution:

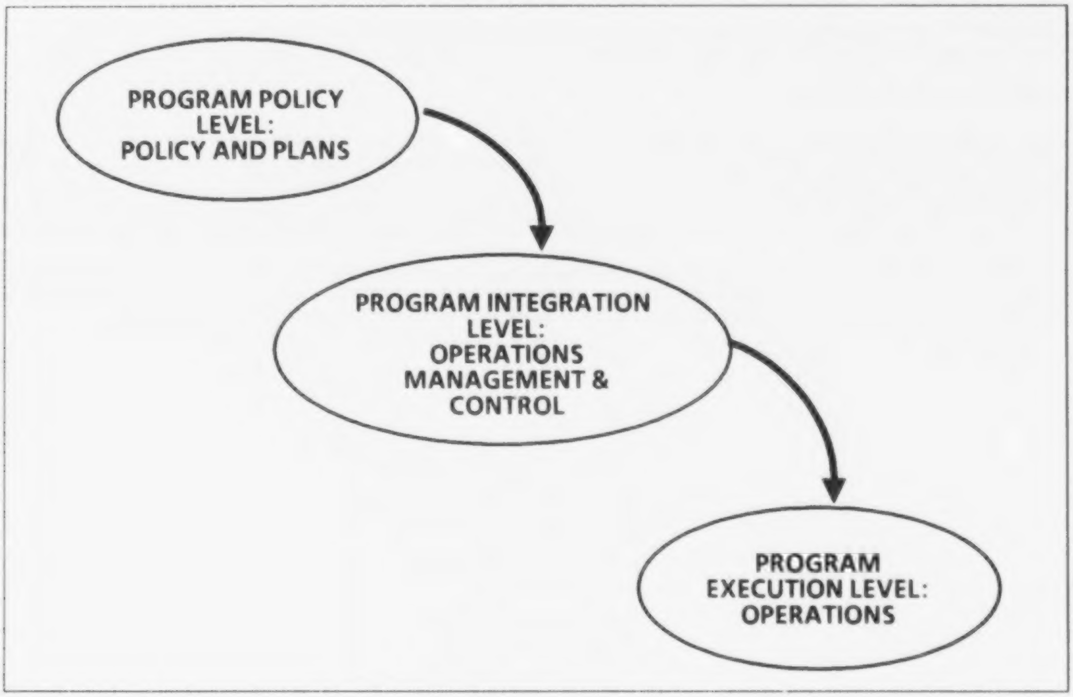

PROGRAM POLICY LEVEL: POLICY AND PLANS
PROGRAM INTEGRATION LEVEL: OPERATIONS MANAGEMENT & CONTROL
PROGRAM EXECUTION LEVEL: OPERATIONS

EXHIBIT-2 SPACE STATION PROGRAM
HIERARCHY OF OPERATIONS FUNCTIONS

### SPACE STATION OPERATIONS MANAGEMENT FUNCTIONS

- PROGRAM POLICY - Those functions concerned primarily with establishing and coordinating the objectives and policies of the organization. These objectives and policies affect a broad range of users and institutional activities.
- PROGRAM INTEGRATION - Those functions concerned primarily with using the established objectives and policies to produce plans and directions for accomplishing stated objectives and policies. While affecting a broad range of users and institutional activities, they become progressively more detailed and focus on managing and controlling operations planning and resource utilization.
- PROGRAM EXECUTION - Those functions whose products and activities result in either an institutional end product; or, products and activities accomplishing the details of a plan in support of a specific end product.

Within each of these three areas, the Task Force took a "top-down" approach to defining the operations job for the Space Station Program. The complete list of top-level operations functions developed by the Space Station Operations Task Force is illustrated in Exhibit 3.

| PROGRAM POLICY FUNCTIONS | PROGRAM INTEGRATION FUNCTIONS | PROGRAM EXECUTION FUNCTIONS |
|---|---|---|
| 1. SPACE STATION PROGRAM OPERATIONS OBJECTIVES & POLICY FORMULATION | 1. INTEGRATED OPERATIONS PLANNING (SEPARATE FOR MANNED BASE AND PLATFORMS EXCEPT FOR COP SERVICING)<br>1A. TACTICAL OPERATIONS PLANNING (MANNED BASE & PLATFORMS)<br>1B. MANNED BASE INCREMENT PLANNING (INCLUDES COP SERVICING) | 1. MANNED BASE SYSTEM OPERATIONS |
| 2. STRATEGIC UTILIZATION & OPERATIONS PLANNING | 2. USER INTEGRATION & ACCOMMODATION SERVICES | 2. MANNED BASE USER OPERATIONS SUPPORT |
| 3. INTERNATIONAL NEGOTIATIONS | 3. MANNED BASE & SUPPORT SYSTEM ENGINEERING & INTEGRATION | 3. PLATFORM(S) SYSTEM OPERATIONS |
| 4. EVOLUTION PLANNING | 4. PLATFORM & SUPPORT SYSTEMS ENGINEERING & INTEGRATION | 4. PLATFORM USER OPERATIONS SUPPORT |
| 5. SAFETY, RELIABILITY/ MAINTAINABILITY & QUALITY ASSURANCE | 5. INFORMATION & NETWORK SYSTEMS ENGINEERING & INTEGRATION | 5. PREFLIGHT/POSTFLIGHT OPERATIONS |
| 6. BUDGET PLANNING & CONTROL | 6. SAFETY, RELIABILITY/MAINTAINABILITY & QUALITY ASSURANCE | 6. INTEGRATED LOGISTICS OPERATIONS |
| 7. TRANSPORTATION SERVICES PLANNING | 7. BUDGET ADMINISTRATION & COST CONTROL | 7. INFORMATION SYSTEM OPERATIONS |
| 8. MARKETING & USER ANALYSIS | 8. INTEGRATED LOGISTICS SYSTEMS | 8. SUSTAINING ENGINEERING<br>8A. SPACE SYSTEMS<br>8B. GROUND SYSTEMS<br>8C. PAYLOAD INTERFACE ENGINEERING & INTEGRATION |
|  | 9. CONFIGURATION CONTROL (SPACE SYSTEMS, INTERFACING GROUND SYSTEMS, PAYLOAD INTERFACES, AND PROGRAM INTEGRATION-LEVEL OPERATIONS PLANS) | 9. CONFIGURATION MANAGEMENT<br>9A. SPACE SYSTEMS<br>9B. GROUND SYSTEMS<br>9C. PAYLOAD INTERFACES<br>9D. EXECUTION-LEVEL OPERATIONS PLANS & PROCEDURES (INCLUDING CONTROL) |
|  |  | 10. SAFETY, RELIABILITY/MAINTAINABILITY & QUALITY ASSURANCE |
|  |  | 11. OPERATOR TRAINING (CREW & GROUND PERSONNEL) |

EXHIBIT-3 SPACE STATION PROGRAM KEY OPERATIONS FUNCTIONS

## 3. CRITERIA FOR DEVELOPING THE OPERATIONS FUNCTIONS

There were several important criteria applied during the process of defining the "what" of the operations job. These were:

- The functions were limited to those directly related to operations. Institutional functions of the Partners and their various centers were assumed to be in place and providing required support in areas such as facilities, personnel, and finance.
- The operations functions describe the end-to-end operations job without regard to "who" performed the job or "where" the job would be performed.
- The initial functional definitions recognized the differences in the operations of the manned based and the unmanned/man-tended platforms and listed separate functional areas at the Program Integration and Program Execution levels. This is particularly true for the polar orbiting platforms which operate independently of the manned base and co-orbiting platforms in all operational phases.
- A great deal of emphasis was placed on the concept of "value-added" in defining functions. In general, if the products of a functional area did not add value to the next lower level in the hierarchy, the function was either deleted or redefined.
- Functions were defined in such a way as to promote delegation of authority and responsibility to the lowest possible level and with clear, simple lines of communication to other functional areas.
- For completeness, the operations functions include functions performed by organizations other than NASA's Office of Space Station or the offices of the International Partners responsible for Space Station Program activities. Examples include communications and tracking services provided by Partner organizations and NASA's Office of Spaceflight Tracking and Data Systems, safety and quality assurance provided by NASA's Office of Safety, Reliability, Maintainability, and Quality Assurance, and space transportation services provided by NASA's Office of Spaceflight.

## 4. FUNCTIONAL AREA PRODUCTS AND END-TO-END FUNCTIONAL PRODUCT FLOW.

The top-level functions illustrated in Exhibit 3 were further developed to illustrate specific activities, products, and interfaces to other functional areas. The results are displayed in Exhibit 4.

STRATEGIC UTILIZATION &
OPERATIONS PLANNING:
MULTILATERAL CONTROL BOARD
P2-C

1. RESOURCE ALLOCATION FOR STATION OPS, G&E (P2-A)
2. PARTNER RESOURCE ALLOCATION (P2-B)
3. APPROVED INTERNATIONAL USER LIST (P2-B)
4. GROWTH PLANS (P2-A)
5. PROCURED TRANSPORTATION SLOTS (P7)

1. APPROVED CONSOLIDATED UTILIZATION PLAN (I1-A)
   - 5 YEAR STATION RESOURCE ALLOCATION
   - SELECTED USERS WITH YEAR AND PRIORITY ASSIGNMENTS
   - MAJOR STATION CAPABILITY ENHANCEMENT PLANS
   - 5 YEAR NSTS/ELV TRANSPORTATION PLAN (W/VEHICLES & APPROX. LAUNCH DATES)
2. USER RESOURCE ALLOCATION BY YEAR (P9)

1. Analysis of user requirements, partner resource allocations, and approved users in consideration of 5 year projected Station resource availabilities and core resource requirements. The overall objective in the decision process is to dedicate the maximum level of resources over the long term to the accomplishment of payload activity while at the same time providing adequate allowance for maintenance of Station systems and enhancement of payload accomodation ability. (1.1.4)

2. Finalization of overall allocation of resources to users vs. Station core activities (maintenance, growth, testing, etc.) on a year-by-year basis. (1.1)

3. Finalization of list of international users on a yearly basis. (5.5.2)

4. Final approval of resource division between international users. (5.5)

5. Prioritization of users and payloads; Scheduling done on a yearly basis. (5.5.2)

6. Review and final approval of plans for Station enhancement put forth by the Evolution Planning function, negotiated and approved by the Systems Operations Panel.

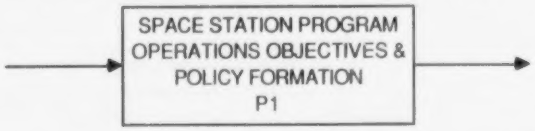
7. Approval of transportation capability procured by Transportation Services, and incorporation into the Consolidated Utilization Plan.

EXHIBIT 4 - SPACE STATION PROGRAM POLICY FUNCTIONS AND PRODUCTS

In Exhibit 4, inputs are provided in the form of products or information from other functional areas. In addition to the name of the input product, the source code is provided in parentheses. For example, input item 1 "Resource Allocation for Station Operations (P2-A), is a product from the Strategic Utilization and Operations Planning, Systems Operations Panel function. The specific activities occurring in each function are defined at the bottom of the chart. These definitions were developed by the SSOTF using existing Program documentation ("Space Station Operations Functions" dated 10/15/86 and JSC 30000) as reference sources. The numbers in parentheses following a definition (e.g., 1.1.4 in item 1) refer to paragraphs in the "Space Station Operations Functions" document. Additional definitions were prepared by the SSOTF to completely describe all activities necessary to develop the output products for each functional area.

As noted earlier, emphasis was placed on "value-addded" products and clear lines of communications among functional areas. A complete listing of these detailed functional definitions with their associated products follow.

## SPACE STATION
## PROGRAM POLICY FUNCTIONS AND PRODUCTS



1. NATIONALLY ORIENTED AND INTEGRATED UTILIZATION REQUIREMENTS
2. MOU's (P3)
3. POLITICAL INPUTS
    - NATIONAL GOALS
    - PROJECTED BUDGETS
4. INTERNATIONAL DEVELOPMENT AND OPERATIONS SCHEDULES (P3)
5. FUTURE BUDGET REQUIREMENTS (P6)
6. FUNDING ALLOCATIONS (EXTERNAL)

1. SCHEDULE GOALS (P2)
2. CAPABILITY GOALS (P2)
3. TRANSPORTATION POLICY (P7)
4. BUDGET GOALS (P6)
5. MARKETING POLICY (P8)
6. ROLES, RESPONSIBILITIES AND GUIDELINES
7. NATIONAL GOALS
8. SR/M&QA POLICY (P5)
9. FUNDING REQUESTS (EXTERNAL)
10. COST, RISK ASSESSMENTS

1. Overall program management function. Ultimately responsible for all policy-level products and the overall management and control of the Space Station Program.

2. Analysis of internal and external environment.

3. Goals and objectives formulation (generally in terms of program capabilities and desired resource allocation and utilization policies). (1.1)

4. Strategies to achieve objectives. Key items include changes in capabilities, technology development and incorporation, marketing policies, pricing policies, and transportation and logistics policies. (1.1.1,1.1.3)

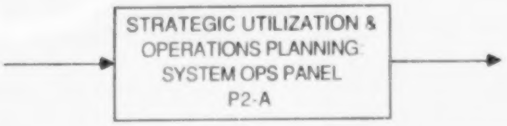
5. Develops policies for recovering appropriate Space Station operating costs from users. (1.1.3)

6. Sponsors advisory groups in support of user requirements definition, user prioritization, and user input to station system requirements, designs, and operational approaches. (1.5.4)

7. Submit requests to non NASA government agencies in charge of overall Space Station Program funding.

8. Performance of cost and risk assessments, and other studies to assist in the formulation of Program goals, priorities, and direction.

## SPACE STATION
## PROGRAM POLICY FUNCTIONS AND PRODUCTS



1. MOU's (P3)
2. SCHEDULE GOALS (P1)
3. GROWTH PLANS (P4)
4. GROWTH & EVOLUTION TRANSPORTATION REQUIREMENTS (P4)
5. PROCURED TRANSPORTATION SLOTS (P7)
6. 5 YEAR TOTAL STATION RESOURCE AVAILABILITY (I1-A.3)
7. 5 YEAR OVERHEAD RESOURCE REQUIREMENTS (I1-A.3)
8. 5 YEAR DESIRED MARGINAL RESOURCE REQUIREMENTS FOR TESTING, MAJOR MAINTENANCE, ETC. (I1-A.3)
9. 5 YEAR TRANSPORTATION REQUIREMENTS FOR STATION OPS & MAINTENANCE (I1-A.3)

1. ALLOCATION OF RESOURCES FOR STATION CORE OPERATIONS (P2-C)
2. ALLOCATION OF RESOURCES FOR STATION GROWTH AND EVOLUTION (P2-C)
3. 5 YEAR TRANSPORTATION REQUIREMENTS FOR STATION OPS AND GROWTH (P7)
4. DATA SYSTEMS & UTILIZATION POLICIES FOR STATION USE (I5)

1. Responsible, in conjunction with the User Operations Panel, for implementing Memoranda of Understanding (MOU's) between the partner nations with respect to the Space Station resources and their allocation between Station operations and the user community. (1.1.4)

2. Consolidation of transport requirements for Station operations, maintenance and growth, for submission to the Transportation Services function.

3. Allocation of non-optional Station resource requirements needed for proper functioning of the Station. (1.1.4)

4. Through negotiation with User Ops Panel, 5 year resource allocations made for Station core operations (day-to-day operation, major maintenance, repair, testing, etc.). (1.1.4)

5. Negotiation for 5 year schedule of Station enhancements, growth and evolution.

6. Formulation of policies and long range plans concerning data system utilization for Station operations.

## SPACE STATION
## PROGRAM POLICY FUNCTIONS AND PRODUCTS

STRATEGIC UTILIZATION &
OPERATIONS PLANNING:
INTERNATIONAL USER OPS PANEL
P2-B

1. MOU's (P3)
2. USER RESOURCE REQUESTS (P9)
3. NATIONALLY SELECTED USERS (P9)
4. GROWTH PLANS (P4)
5. PROCURED TRANSPORTATION SLOTS (P7)
6. 5 YEAR TRANSPORTATION REQUIREMENTS FOR SELECTED USER SUPPORT (I1-A.1)
7. TRANSPORTATION REQUIREMENTS FOR POTENTIAL USERS (P9)

1. PARTNER RESOURCE ALLOCATIONS (P2-C)
2. APPROVED INTERNATIONAL USER LIST (P2-C)
3. 5 YEAR TRANSPORTATION REQUIREMENTS FOR USER SUPPORT (P7)
4. DATA SYSTEMS & UTILIZATION POLICIES FOR USER SUPPORT (I5)

1. Responsible for implementing bilateral Memoranda of Understanding (MOU's) pertaining to the division of user-designated resources between user boards of the different partner nations. (1.1)

2. Analysis of user resource requests with respect to budget allocations, transportation considerations, and MOU's for evaluation and approval of selected payload lists from user boards. (1.1.4)

3. Overall guidelines are formulated as to the division of resources among partners, and to general priorities in resource allocation. (1.1.4)

4. Consolidation of transportation requirements for selected users (in C.U.P.) and potential users (from User Boards) for submission of overall 5 year user transportation requirements to the Transportation Services function.

5. Formulation of policies and long-range plans concerning data system utilization for support of Station users.

## SPACE STATION
## PROGRAM POLICY FUNCTIONS AND PRODUCTS

STRATEGIC UTILIZATION &
OPERATIONS PLANNING:
MULTILATERAL CONTROL BOARD
P2-C

1. RESOURCE ALLOCATION FOR STATION OPS, G&E (P2-A)
2. PARTNER RESOURCE ALLOCATION (P2-B)
3. APPROVED INTERNATIONAL USER LIST (P2-B)
4. GROWTH PLANS (P2-A)
5. PROCURED TRANSPORTATION SLOTS (P7)

1. APPROVED CONSOLIDATED UTILIZATION PLAN (I1-A)
   - 5 YEAR STATION RESOURCE ALLOCATION
   - SELECTED USERS WITH YEAR AND PRIORITY ASSIGNMENTS
   - MAJOR STATION CAPABILITY ENHANCEMENT PLANS
   - 5 YEAR NSTS/ELV TRANSPORTATION PLAN (W/VEHICLES & APPROX. LAUNCH DATES)
2. USER RESOURCE ALLOCATION BY YEAR (P9)

1. Analysis of user requirements, partner resource allocations, and approved users in consideration of 5 year projected Station resource availabilities and core resource requirements. The overall objective in the decision process is to dedicate the maximum level of resources over the long term to the accomplishment of payload activity while at the same time providing adequate allowance for maintenance of Station systems and enhancement of payload accomodation ability. (1.1.4)

2. Finalization of overall allocation of resources to users vs. Station core activities (maintenance, growth, testing, etc.) on a year-by-year basis. (1.1)

3. Finalization of list of international users on a yearly basis. (5.5.2)

4. Final approval of resource division between international users. (5.5)

5. Prioritization of users and payloads. Scheduling done on a yearly basis. (5.5.2)

6. Review and final approval of plans for Station enhancement put forth by the Evolution Planning function, negotiated and approved by the Systems Operations Panel.

7. Approval of transportation capability procured by Transportation Services, and incorporation into the Consolidated Utilization Plan.

## SPACE STATION
## PROGRAM POLICY FUNCTIONS & PRODUCTS

INTERNATIONAL
NEGOTIATIONS
P3

1. USER REQUIREMENTS
2. NATIONAL GOALS (P1)
3. STATION SYSTEM CAPABILITIES
4. CONFIGURATION, GROWTH & EVOLUTION PLANS (P4)
5. SCHEDULES (P1)
6. SR/M&QA POLICY (P5)
7. BUDGET GOALS (P6)
8. PRICING POLICY (P6)
9. ROLES AND RESPONSIBILITIES (P1)
10. TRANSPORTATION POLICY (P7)
11. INTERNATIONAL CREW UTILILIZATION POLICY (P1)

1. MOU's (P2)
2. FUNDING REQUIREMENTS (P2)
3. DEVELOPMENT AND OPERATIONS SCHEDULES (P2)
4. PARTNER COMMITMENTS (P2)

1. Develop bilateral Memoranda of Understanding (MOU) between the United States and the international partners of the Space Station Program. These MOU's describe funding levels, responsibilities for space and ground segment development, operations, management concepts, development and operations schedules. (5.5.1,5.5.3)

2. Support for the analysis and development required for negotiation of agreements with international partners. (5.5.1)

3. Provide operational evaluation of domestic and international roles and missions. (5.5.2)

4. Analyze domestic and international functional interfaces to ensure clear authority and procedural protocol. (5.5.3)

5. Negotiate roles and responsibilities with international partners. (5.5.1)

## SPACE STATION
## PROGRAM POLICY FUNCTIONS AND PRODUCTS

EVOLUTION
PLANNING
P4

1. SCHEDULE GOALS (P1)
2. CAPABILITY GOALS (P1)
3. BUDGET GOALS/PROJECTIONS (P1)
4. SR/M&QA POLICY (P5)
5. CAPABILITY REQUIREMENTS (P2)
6. 5-YEAR DEVELOPMENT BUDGETS (P2)
7. 5-YEAR DEVELOPMENT SCHEDULES (P2)
8. INTERNATIONAL DEVELOPMENT AND OPERATIONS SCHEDULES (P3)
9. STATION, TRANSPORTATION, INSTITUTIONAL, INFORMATION SYSTEM CAPABILITIES
10. PROJECTED REQUIREMENTS/MARKET RESEARCH RESULTS (P8)
11. SYSTEMS PERFORMANCE EVALUATIONS (P5)
12. GROWTH REQUIREMENTS (P8,I2)

1. GROWTH PLANS, CONFIGURATIONS (P2,I1)
2. BUDGET REQUIREMENTS (P2)
3. TECHNOLOGY REQUIREMENTS (P2)
4. GROWTH AND EVOLUTION EVALUATION REQUESTS (E8-A)
5. GROWTH & EVOLUTION TRANSPORTATION REQUIREMENTS (P2-A)

1. Analysis of growth requirements, goals and policies, budget and technology limitations to formulate plans for station growth.

2. Analysis of all strategic plans and policies to determine the direction and extent of evolution.

3. Determine design impacts, particularly hooks and scars on the current station configuration at any phase of the program, to allow for further evolution.

4. Establish plans for the use of automation and robotics as an aid to operations.

5. Set up performance assessment system to identify opportunities/requirements for automation and evolution paths.

6. Perform life cycle cost studies to guide planning for effective evolution at the lowest possible cost to the Program.

7. Manage Space Station system growth and evolution programs.

8. Formulate transportation requirements for growth and evolution plans.

## SPACE STATION
## PROGRAM POLICY FUNCTIONS & PRODUCTS

**SAFETY, RELIABILITY/ MAINTAINABILITY & QUALITY ASSURANCE**
**P5**

1. SR/M&QA POLICY (P1)
2. G&E PLAN (P4)

1. SAFETY REQUIREMENTS & DIRECTIVES
2. SYSTEM MODIFICATION AND GROWTH AND EVOLUTION PLAN REVIEWS (P4)

1. Program safety and quality assurance policy implementation and management of Integration and Execution level safety functions.

2. Independent reviews, analyses, and reports on proposed system modification and growth and evolution plans.

## SPACE STATION
## PROGRAM POLICY FUNCTIONS & PRODUCTS

**BUDGET PLANNING AND CONTROL**
**P6**

1. OPERATIONS BUDGET GOALS (P1)
2. DEVELOPMENT BUDGET GOALS (P1)
3. EXPENDITURE REPORTS/OPERATIONAL VARIANCES (I7)
4. FINANCIAL RESOURCE ALLOCATIONS (EXTERNAL)

1. ACCOUNTING AND CONTROL GUIDELINES (I7)
2. AUDITS
3. OPERATIONS BUDGETS (I7)
4. DEVELOPMENT BUDGETS (I7)
5. OPERATIONS BUDGET ANALYSES
6. FUTURE BUDGET REQUIREMENTS (P1)

1. Identify financial objectives and issue guidelines. (5.1.7)

2. Submit budget. (5.1.7)

3. Integrate, analyze, validate, revise budget. (5.1.7)

4. Develop models to estimate costs. (5.1.7)

5. Analyze resources available. (5.1.7)

6. Defend and justify budget. (5.1.7)

7. Develop revised execution plan. (5.1.7)

## SPACE STATION
## PROGRAM POLICY FUNCTIONS AND PRODUCTS

**TRANSPORTATION SERVICES PLANNING**
**P7**

1. TRANSPORTATION BUDGETS (P6)
2. NSTS/ELV SCHEDULES (P11)
3. NSTS/ELV GROWTH, DEVELOPMENT, IMPROVEMENT PROSPECTS (P11)
4. PROJECTED TRANSPORTATION COSTS (P11)
5. NSTS/ELV TRANSPORTATION ALLOCATIONS (P11)
6. 5 YEAR TRANSPORTATION REQUIREMENTS FOR STATION OPERATIONS & GROWTH (P2-A)
7. 5 YEAR TRANSPORTATION REQUIREMENTS FOR USER SUPPORT (P2-B)

1. 5 YEAR NSTS TRANSPORTATION SLOT ALLOCATIONS (P2)
2. 5 YEAR ELV TRANSPORTATION SLOT ALLOCATIONS (P2)
3. NSTS/ELV TRANSPORTATION REQUESTS (P11)

1. Analysis of input factors, schedules, budget considerations, and improvement prospects for projecting long-term ground and transport capability and availability.

2. Perform feasibility studies to assess the utility of development and improvement of existing transportation methods and ground systems.

3. Formulation of goals for acquisition of future transportation capability based upon projections of transportation demand by users and Station operation and growth (with System Operations Panel).

4. Procurement and arrangement of NSTS/ELV transportation services.

5. Analysis of transportation requirements, availabilities, costs, to determine the optimal mix (NSTS vs. ELV) of transportation services.

## SPACE STATION
## PROGRAM POLICY FUNCTIONS & PRODUCTS

**MARKETING AND USER ANALYSIS**
**P8**

1. MARKETING POLICY (P1)
2. POTENTIAL USERS
3. SELECTED USERS (P2)
4. SAFETY STANDARDS (P5)
5. BASELINE SYSTEM CAPABILITIES AND CONFIGURATION (I9)

1. USER CONTRACTS & SERVICE AGREEMENTS (I2)
2. PROJECTED USER REQUIREMENTS (P9)
3. MARKETING EFFORTS (TO POTENTIAL USERS)

1. Prepare and execute a marketing plan. The objectives of the plan are to identify potential users or user groups. (1.1.1)

2. Contract negotiations with selected users, service agreements. (5.5.1.1.1.6)

3. Perform user market research. (1.1.1)

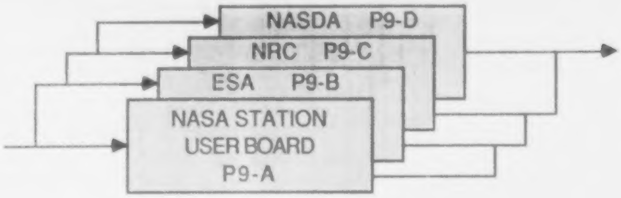
4. Provide support to user advocate groups in developing potential users. (1.5.4)

5. Prepare and distribute marketing and technical brochures. Participate in user workshops, Space Station-sponsored symposia, etc. (1.1.1)

6. Identify potential users for Station & platforms. (1.1.1)

## SPACE STATION
## PROGRAM POLICY FUNCTIONS AND PRODUCTS

NOTE: This is not a Station organization function!



1. NATIONALLY SELECTED USERS (P2-C)
2. USER TOTAL YEARLY RESOURCE ALLOCATIONS (BY PARTNER NATION) (P2-C)
3. CANDIDATE PAYLOADS (P10)
4. RESULTS OF PAYLOAD FEASIBILITY ANALYSES (SYSTEMS AND OPERATIONS) (I2)

1. RESOURCE REQUESTS (P2-B)
2. NATIONALLY SELECTED USERS (P2-B)
3. PAYLOADS FOR FEASIBILITY ANALYSES (I2)
4. YEARLY USER CLASS RESOURCE ALLOCATIONS (P10)
5. INTERNAL RESOURCE ALLOCATION POLICY (P10)
6. TRANSPORTATION REQUIREMENTS FOR POTENTIAL USERS (P2-B)

1. Provide estimates of Space Station resource requirements based on their projections of potential users. (1.1)

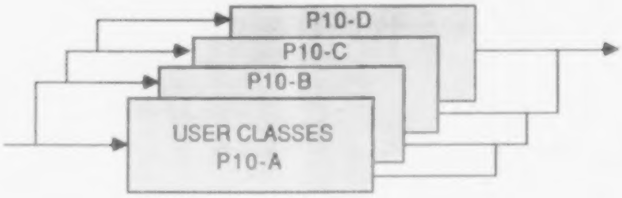
2. Analysis of candidate payloads for technical suitability, compatibility with allocated resources, etc., for recommendation to Strategic Utilization Planning function. (1.1.4)

3. Analysis of user class needs, their respective payload requirements and total resource allocations, for the purpose of division of nationally allocated resources among the various user classes on a yearly basis. (1.1.4)

4. Implementation of Presidential Space Station Utilization Policy (in the case of the U.S. User Board) by the NASA Associate Administrator, who is the chairman of the board. (1.1)

## SPACE STATION
## PROGRAM POLICY FUNCTIONS AND PRODUCTS

NOTE: This is not a Station organization function!



1. YEARLY USER CLASS RESOURCE ALLOCATIONS (P9)
2. MARKETING RESEARCH AND ASSISTANCE (P8)
3. RESULTS OF FEASIBILITY ANALYSES (I2)

1. CANDIDATE PAYLOADS (P9)

1. User classes select users, both government and commercial, on the basis of feasibility analyses and resources made available by user board. Domestic examples of user classes would be commercial corporations, as well as NASA Code E, I, and R.

## SPACE STATION
## PROGRAM POLICY FUNCTIONS AND PRODUCTS

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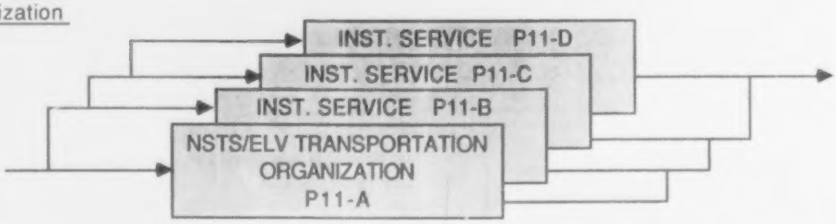

INST. SERVICE P11-D
INST. SERVICE P11-C
INST. SERVICE P11-B
NSTS/ELV TRANSPORTATION ORGANIZATION P11-A

1. TRANSPORTATION SERVICE REQUESTS (P7)
2. OTHER INSTITUTIONAL SERVICE REQUESTS (I1)

1. TRANSPORTATION SERVICE SCHEDULES AND CAPABILITIES (P7)
2. TRANSPORTATION SERVICE ALLOCATIONS (P7)
3. OTHER SERVICE (GROUND, PAYLOAD HANDLING, ETC.) SCHEDULES AND CAPABILITIES (I1)
4. OTHER SERVICE (GROUND, PAYLOAD HANDLING, ETC.) ALLOCATIONS (I1)

1. Provide the Transportation Services and Ground Resource Planning functions with information regarding the kinds of services available, their capabilities, schedules and their availabilities.

2. Reserve services (NSTS, ELV, ground, engineering, payload handling, etc.) for each increment, according to requests issued by the Transportation Services and Ground Resource Planning functions.

## SPACE STATION
## PROGRAM INTEGRATION FUNCTIONS AND PRODUCTS

**INTEGRATED OPS PLANNING:**
**TACTICAL OPS PLANNING**
**I1-A**

1. CONSOLIDATED UTILIZATION PLAN (P2-C):
    - 5 YEAR STATION/USER RESOURCE ALLOCATION
    - SELECTED USERS WITH YEAR AND PRIORITY ASSIGNMENTS
    - MAJOR STATION ENHANCEMENT PLANS
    - 5 YEAR NSTS/ELV TRANSPORTATION PLAN (W/VEHICLES & APPROX. LAUNCH DATES)
2. STATION SUPPORT PLAN (I1-A.3)
3. INCREMENT-BY-INCREMENT CORE REQUIREMENTS (I1-A.3)
4. INCREMENT-BY-INCREMENT OPTIONAL REQUIREMENTS (I1-A.3)
5. INCREMENT-BY-INCREMENT RESOURCES AVAILABLE (I1-A.3)
6. INCREMENT REQUIREMENT CHANGE REQUESTS (I1-B)
7. TACTICAL OPS CHANGE REQUESTS (I1-B)
8. INTEGRATED PLAN ENGINEERING ANALYSES (E8-C)
9. MANIFESTED PAYLOAD TRANSPORTATION REQUIREMENTS (I1-A.1)
10. PAYLOAD SUPPORT PLAN (I1-A.1)
11. LOGISTIC SUPPORT PLANS (I8)
12. GSE AND PROCESSING SUPPORT

1. RESOURCES AVAILABLE FOR STATION SUPPORT (I1-A.3)
2. RESOURCES AVAILABLE TO USERS BY INCREMENT (I1-A.1)
3. GROUND SUPPORT REQUIREMENTS (I1-A.2)
4. TACTICAL OPERATIONS PLAN (I1-B):
    - PAYLOAD ELEMENTS FOR NEXT 16 INCREMENTS
    - STATION ELEMENTS FOR NEXT 16 INCREMENTS
    - STATION OPS REQUIREMENTS FOR NEXT 16 INCREMENTS

1. Analysis of increment-by-increment station core and optional requirements, resources available, increment change requests in order to make final resource allocations to User Support Planning function and Station Operations and Maintenence Planning function for the next 16 flight increments.

2. Development of integrated ground support requirements for submission to Ground Resource Planning function.

3. Analysis of transportation availability, transport requirements, payload-to-increment assignments (Payload Support Plan), Station activity-to-increment assignments (Station Support Plan), increment change requests. Commission integrated plan engineering analyses performed by sustaining engineering support.

4. Development and publication of the Tactical Operations Plan (TOP), describing the payload elements, Station elements, and Station operations requirements for each of the next 16 flight increments.

5. Development of specific objectives for each flight increment.

6. Final approval of the TOP by the Program Operations Control Board (POCB).

7. Overall Station, platform, and supporting ground systems management. Responsible for ensuring compliance with established policies. Responsible for all tactical and execution level products and activities. (5.1.10)

8. Controls and documents the baseline system configuration and capabilities. Documentation includes the Program Definition and Requirements Document (PDRD), Architecture Control Document (ACD), and Baseline Control Document (BCD).

9. Management of key operations facilities. (5.2.1) Develops and tracks construction of facilities requirements through the approval cycle. (5.2.3)

## SPACE STATION
## PROGRAM INTEGRATION FUNCTIONS AND PRODUCTS

TACTICAL OPS PLANNING:
USER SUPPORT PLANNING
I1-A.1

1. INCREMENT-BY-INCREMENT STATION RESOURCE ALLOCATIONS TO USER COMMUNITY (I1-A)
2. NEW USER SUPPORT REQUIREMENTS (I2)
3. PAYLOAD-TO-INCREMENT ASSIGNMENT SUPPORT (I10)
4. RESULTS OF USER-TO-INCREMENT FEASIBILITY AND COMPATIBILITY ANALYSES (I2)
5. CURRENT PAYLOAD STATUS (E2)
6. FUTURE INCREMENT SUPPORT REQUIREMENTS (E2)

1. MANIFESTED PAYLOAD TRANSPORT REQUIREMENTS (I1-A)
2. PAYLOAD SUPPORT PLAN (I1- A)
3. 5 YEAR TRANSPORTATION REQUIREMENTS FOR SELECTED USER SUPPORT (P2-B)

1. Assignment of payloads to flight increments after considering payload priorities, incremental resources, feasibility and compatibility studies, in the Payload Support Plan. Overall objective is to obtain the most efficient matching of payload requirements and Station available resources, while maintaining payload priorities to the extent possible. (1.2)

2. Analysis of new payload support requirements, feasibility and compatibility analyses, and future increment support requirements in consideration of Station resources available per increment. (1.2.1)

3. Development of transportation requirements for currently and newly manifested payloads. (1.2.3)

4. Commission feasibility and compatibility studies of new payloads for a given flight increment. (1.3.1)

5. Formulate long-term transportation requirements for support of users listed in Consolidated Utilization Plan, for submission to Strategic Planning.

## SPACE STATION
## PROGRAM INTEGRATION FUNCTIONS AND PRODUCTS

TACTICAL OPS PLANNING:
GROUND RESOURCE PLANNING
I1-A.2

1. 2 YEAR PRELAUNCH/POSTLANDING OPS REQUIREMENTS (I1-A)
2. PAYLOAD LOGISTICS SUPPORT REQUIREMENTS (E2)
3. CONSUMABLES STATUS (E1)
4. MAINTENANCE STATUS (E1)
8. NON-TRANSPORTATION INSTITUTIONAL SERVICE ALLOCATIONS (P11-B,C,...)

1. NON-TRANSPORTATION INSTITUTIONAL SERVICE REQUESTS (P11-B,C,...)
2. GSE AND PROCESSING SUPPORT CAPABILITIES (I1-A)
3. GSE AND PROCESSING SUPPORT PLANS (I1-A)

1. Analysis of current user payload logistics support requirements, Station real-time problem/resolution impacts.

2. Determination of ground support capability constraints.

3. Maintain launch schedule information provided by transportation vendors. (5.1.1,5.1.2)

4. Procurement of additional NASA institutional services such as ground support, payload handling, etc., and assessment of such capabilities for use in tactical operations planning.

# SPACE STATION
# PROGRAM INTEGRATION FUNCTIONS AND PRODUCTS

## TACTICAL OPS PLANNING: STATION OPS AND MAINTENANCE PLANNING
## I1-A.3

1. RESOURCES AVAILABLE FOR STATION SUPPORT ON AN INCREMENT-BY-INCREMENT BASIS (I1-A)
2. GROWTH AND EVOLUTION PLANS (P4)
3. PERIODIC MAINTENANCE REQUIREMENTS (E8-A)
4. CURRENT USER UPDATED REQUIREMENTS FOR STATION SYSTEMS SUPPORT (E1)
5. COMMON SYSTEM CAPABILITIES (E1)

1. INCREMENT-BY-INCREMENT CORE REQUIREMENTS (I1-A):
    - REQUIRED MAINTENANCE
    - PROVISIONS/CONSUMMABLES
    - STATION CARGO
    - CREW SUPPORT TIME
2. INCREMENT-BY-INCREMENT OPTIONAL REQUIREMENTS (I1-A):
    - OPTIONAL MAINTENANCE
    - GROWTH AND EVOLUTION PLANS
3. INCREMENT-BY-INCREMENT RESOURCES AVAILABLE (I1):
    - CREW TIME
    - POWER/THERMAL
    - ATTACH POINTS
    - RACK SPACE
4. STATION SUPPORT PLAN (I1-A)
5. 5 YEAR TRANSPORTATION REQUIREMENTS FOR STATION OPS & MAINTENANCE (P2-A)

1. Analysis of required Station core support requirements in consideration of resources allocated for non-user support by the Consolidated Utilization Plan. Overall objective is to allocate resources needed for non-optional support on an increment-by-increment basis before considering the resources available for payloads and other non-essential activity.

2. Development of optional Station support requirements (maintenance, growth and evolution) on an increment-by-increment basis from research performed in the Sustaining Engineering function.

3. Consolidation of information from sustaining engineering and real-time Station management function as to crew, power/thermal, attach point, rack space resources available.

4. Projection of available resources, optional and non-optional Station support requirements into the next 16 flight increments (approx. 2 years).

5. Development of the Station support requirements for the Tactical Operations Plan. These requirements outline proposed Station activity-to-increment assignments for Station support, as a recommendation to the Integrated Operations Planning function, for final approval by the Program Operations Control Board (POCB).

6. Formulation of long-term transportation requirements for Station operations and maintenance, for use in Strategic Utilization Planning.

# SPACE STATION
# PROGRAM INTEGRATION FUNCTIONS AND PRODUCTS

## MANNED BASE INCREMENT PLANNING: CRITICAL PATH SCHEDULING
I1-B.1

1. TACTICAL OPERATIONS PLAN (I1-A):
   - PAYLOAD ASSIGNMENTS AND ALLOCATED RESOURCES
   - CREW NUMBER AND SKILL REQUIREMENTS
   - TRANSPORTATION SCHEDULES, VEHICLES, MASS/ELEMENT ASSIGNMENTS
   - STATION ACTIVITY REQUIREMENTS (MAINTENANCE, MODIFICATIONS GROWTH & EVOLUTION, TEST, C&O)
   - LOGISTICS ASSIGNMENTS AND UP/DOWN MANIFEST
2. CURRENT INCREMENT RESOURCE AVAILABILITY INFORMATION (E1)

1. TACTICAL OPERATIONS CHANGE REQUESTS (I1-A)
2. SPACE OPERATIONS MILESTONE SCHEDULE (I1-B.2)
3. GROUND OPERATIONS MILESTONE SCHEDULE (I1-B.3)
4. FLIGHT INCREMENT PLANS (E1,E2)

1. Analysis of transportation, maintenance, and payload schedules from Tactical Operations Plan. Identification of critical path, scheduling of critical events.

2. Development of milestone schedules for space and ground operations.

3. Responsibility for monitoring scheduled activities and making appropriate schedule modifications.

4. Responsibility for insuring that tasks on critical path are accomplished according to schedule.

5. Authority to redirect efforts of support functions in order to maintain schedule.

6. Identification of problems with regard to scheduling in the Tactical Operations Plan, and submission of tactical operations change requests to the Integrated Operations Planning function.

7. Selection and assignment of Increment Management Team.

8. Planning of flight increment and transfer operation.

## SPACE STATION
## PROGRAM INTEGRATION FUNCTIONS AND PRODUCTS

### MANNED BASE INCREMENT PLANNING:
### SPACE OPERATIONS PLANNING
### I1-B.2

1. TACTICAL OPERATIONS PLAN (I1-A):
    - PAYLOAD ASSIGNMENTS AND ALLOCATED RESOURCES
    - CREW NUMBER AND SKILL REQUIREMENTS
    - TRANSPORTATION SCHEDULES, VEHICLES, MASS/ELEMENT ASSIGNMENTS
    - STATION ACTIVITY REQUIREMENTS (MAINTENANCE, MODIFICATIONS GROWTH & EVOLUTION, TEST, C&O)
    - LOGISTICS ASSIGNMENTS AND UP/DOWN MANIFEST
2. CURRENT INCREMENT RESOURCE AVAILABILITY INFORMATION (E1)
3. SPACE OPERATIONS MILESTONE SCHEDULE (I1-B.1)
4. CREW, FLIGHT CONTROLLER TRAINING PLANS (E11)
5. REAL-TIME FACILITY SUPPORT (E5)
6. STRUCTURAL, MASS, THERMAL ANALYSES (E8-A)
7. CREW PROCEDURES SUPPORT
8. PAYLOAD AND STATION LOGISTICS SUPPORT ANALYSES (I8)
9. ENGINEERING ANALYSES (E8-A)

1. TACTICAL OPERATIONS CHANGE REQUESTS (I1-A)
2. INCREMENT EXECUTION PLAN (E1,E2)
3. TRAINING REQUIREMENTS (E11)
4. FACILITIES REQUIREMENTS (E5)
5. PAYLOAD AND STATION ENGINEERING DATA (E8-A)
6. PROCEDURES REQUIREMENTS
7. LOGISTICS REQUIREMENTS (I8)
8. FLIGHT PROCEDURE DOCUMENTATION REQUIREMENTS
9. PAYLOAD TEST AND INTEGRATION PLANS (I3,I4)
10. CREW, FLIGHT CONTROLLER TRAINING REQUIREMENTS (E11)

1. Analysis of resource availability, space operations milestone schedule, training plans, engineering and logistics analyses for development of space operations increment timeline, and for increment preparation. Increment execution plans will operate within the guidelines put forth in the Tactical Operations Plan.

2. Development of crew and flight controller training requirements. (2.2.8)

3. Development of real-time facilities requirements (data, voice, telemetry, etc. ).

4. Integration of payload requirements into flight operation plans. (1.4.2,1.4.3)

5. Development of flight procedure documentation requirements. (2.2.2,2.2.4)

6. Development of Station systems and payload test and integration plan details.

# SPACE STATION
# PROGRAM INTEGRATION FUNCTIONS AND PRODUCTS

## MANNED BASE INCREMENT PLANNING: GROUND OPERATIONS PLANNING
## I1-B.3

1. TACTICAL OPERATIONS PLAN (I1-A):
   - PAYLOAD ASSIGNMENTS AND ALLOCATED RESOURCES
   - CREW NUMBER AND SKILL REQUIREMENTS
   - TRANSPORTATION SCHEDULES, VEHICLES, MASS/ELEMENT ASSIGNMENTS
   - STATION ACTIVITY REQUIREMENTS (MAINTENANCE, MODIFICATIONS GROWTH & EVOLUTION, TEST, C&O)
   - LOGISTICS ASSIGNMENTS AND UP/DOWN MANIFEST
2. CURRENT INCREMENT RESOURCE AVAILABILITY INFORMATION (E1)
3. GROUND OPERATIONS MILESTONE SCHEDULE (I1-B.1)
4. GROUND OPERATIONS TRAINING PLANS (E11)
5. GROUND LOGISTICS SUPPORT ANALYSES (I8)
6. LAUNCH FACILITY SUPPORT
7. ENGINEERING ANALYSES (E8-B)
8. GROUND PROCEDURE SUPPORT

1. INCREMENT GROUND EXECUTION PLANS (E5,E6)
2. TACTICAL OPERATIONS CHANGE REQUESTS (I1-A)
3. GROUND SUPPORT TRAINING REQUIREMENTS (E11)
4. INCREMENT PLANS (E6)
5. LOGISTICS REQUIREMENTS (I8)
6. LAUNCH FACILITY SUPPORT REQUIREMENTS
7. DATA FOR ENGINEERING ANALYSES (E8-B)
8. MAINTENANCE AND OPERATIONS PROCEDURAL REQUIREMENTS (E1)
9. GROUND OPERATIONS TRAINING REQUIREMENTS (E11)

1. Analysis of resource availability, milestone schedules, training plans, engineering analyses for development of increment ground operations activities and timelines. Plans will schedule activities efficiently and effectively, within the guidelines put forth by the Tactical Operations Plan.

2. Formulation of increment execution plans, submission to ground and logistics operations execution functions.

3. Responsible for review and evaluation of ground operations progress in the ground and logistics operations functions. (3.5,4.9)

4. Development of training requirements for ground operations personnel. (2.2.7,3.5,4.7)

5. Development of ground maintenance and operations plans and procedures. (2.2)

## SPACE STATION
## PROGRAM INTEGRATION FUNCTIONS & PRODUCTS

### USER INTEGRATION AND ACCOMODATION SERVICES
I2

1. SSIS OPS PLAN (E7)
2. SELECTED USER LIST (P2-C)
3. TACTICAL OPS PLAN (I1-A)
4. BASELINE SYSTEM CAPABILITIES & CONFIGURATION (I9)
5. I/F STANDARDS (I1)
6. SAFETY STANDARDS (I6)
7. USER ICD INPUTS (E9,E1,E5)
8. USER CONTRACTS & SERVICE AGREEMENTS (P8)
9. OPS ASSESSMENTS (E1,E3)
10. USER-SYSTEM I/F DESIGN (E9-C)

1. BILLABLE USER SERVICES DATA (P6)
2. SYSTEM ICDs AND PAYLOAD INTEGRATION ANNEXES (E2,E4,USERS)
3. USER I/F DESIGN REQUESTS (E8-C)
4. USER - ELEMENT TEST PROCEDURES (E5)
5. USER DELIVERABLE SCHEDULES (USERS)
6. USER ICDs (E7,E5,E2)
7. PAYLOAD-TO-INCREMENT FEASIBILITY AND COMPATIBILITY ANALYSES (I1-A.1,P9)

1. Provides a single point of contact for all selected users into the Space Station organization and assumes responsibility for user satisfaction.

2. Develops and manages user specific accommodation and interface control documents such as the user-station (user-platform) Interface Control Documents (ICDs), annexes, and transportation system ICDs. (1.2.4, 1.3.2, 1.3.4)

3. Develops user-specific operations and integration plans. (1.2.1, 1.2.2, 1.4.2, 5.1.5)

4. Conducts user-station (user-platform) integration reviews. (1.4.3)

5. Contract support to Marketing and User Analysis function during support services contract negotiations. (1.1.1)

6. Provides ongoing support to users to ensure user objectives are met. Provides definitions of standard and optional services to users. Arranges for optional services at user request. (1.4.4)

7. Arranges and coordinates user training.

8. Provides user requirements to operations analysis and integration functional area. (1.2.4)

9. Supports activities at payload development centers.

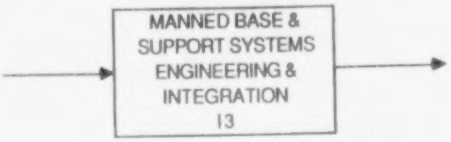
10. Coordinates user requirements with element centers. (1.2.4)

11. Coordinates with international partners/users. (5.6)

12. Develops user ICDs. (1.3.2)

13. Analysis of proposed payloads for feasibility for Station operations and compatibility with existing payloads. (1.3.1,1.4.1)

## SPACE STATION
## PROGRAM INTEGRATION FUNCTIONS & PRODUCTS



1. DEVELOPMENT SCHEDULE (I1)
2. DEVELOPMENT BUDGET (I7)
3. INTERFACE STANDARDS (I1)
4. APPROVED CCB PRODUCTS (I1)
5. PROJECTED USER REQUIREMENTS (I2)
6. GROWTH & EVOLUTION PLAN (I1)
7. TACTICAL OPERATIONS PLAN (I1)
8. STATION HARDWARE ICDs (E9)
9. STATION AND SUPPORT SYSTEM SE&I

1. STATION AND PLATFORM CAPABILITY ENHANCEMENT SPECIFICATIONS (E9)
2. GROUND SEGMENT CAPABILITY ENHANCEMENT SPECIFICATIONS (E9)
3. ENGINEERING CHANGE REQUESTS (ECRs) (I1)
4. COST ESTIMATES (I1)
5. IMPACT ASSESSMENTS (I1)
6. DEVELOPMENT SCHEDULES (E9)
7. PROPOSED SYSTEMS CONFIGURATION AND OPERATIONS CONCEPT CHANGES (I9)
8. STATION INTERELEMENT ICDs (E9)

1. Perform enhancement feasibility and supportability analyses (2.1.1, 2.4.1). Develop subsystem specification and performance requirements.

2. Manage/perform advanced development programs. (2.1.1)

3. Develop engineering change requests (ECRs).

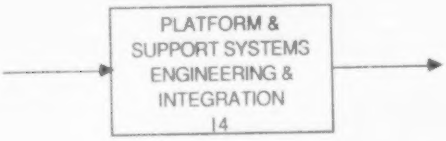
4. Provide cost estimates for proposed system enhancements. (5.4.3)

5. Provide impact assessments for proposed system enhancements.

6. Preparation and management of development programs, schedules.

7. Analysis of present systems, user requirements, Station system goals and policies to assist in the development of the growth and evolution plan.

## SPACE STATION
## PROGRAM INTEGRATION FUNCTIONS & PRODUCTS



1. DEVELOPMENT SCHEDULE (I1)
2. DEVELOPMENT BUDGET (I7)
3. INTERFACE STANDARDS (I1)
4. APPROVED CCB PRODUCTS (I1)
5. PROJECTED USER REQUIREMENTS (I2)
6. GROWTH & EVOLUTION PLAN (I1)
7. TACTICAL OPERATIONS PLAN (I1)
8. PLATFORM HARDWARE ICDs (E9)
9. PLATFORM AND SUPPORT SYSTEM SE&I

1. STATION AND PLATFORM CAPABILITY ENHANCEMENT SPECIFICATIONS (E9)
2. GROUND SEGMENT CAPABILITY ENHANCEMENT SPECIFICATIONS (E9)
3. ENGINEERING CHANGE REQUESTS (ECRs) (I1)
4. COST ESTIMATES (I1)
5. IMPACT ASSESSMENTS (I1)
6. DEVELOPMENT SCHEDULES (E9)
7. FLIGHT ELEMENT TO LAUNCH VEHICLE ICDs (E9)
8. PROPOSED SYSTEMS CONFIGURATION AND OPERATIONS CONCEPT CHANGES (I9)
9. PLATFORM INTERELEMENT ICDs (E9)

1. Perform enhancement feasibility and supportability analyses. (2.1.1, 2.4.1) Develop subystem specification and performance requirements.

2. Manage/perform advanced development programs. (2.1.1)

3. Develop engineering change requests (ECRs).

4. Provide cost estimates for proposed system enhancements. (5.4.3)

5. Provide impact assessments for proposed system enhancements. (2.3.2,2.3.3)

6. Preparation and management of development programs, schedules.

7. Analysis of present systems, user requirements, platform-system goals and policies to assist in the development of the growth and evolution plan.

## SPACE STATION
## PROGRAM INTEGRATION FUNCTIONS & PRODUCTS

### INFORMATION & NETWORK SYSTEMS ENGINEERING & INTEGRATION
### I5

1. TACTICAL OPERATIONS PLAN (I1)
2. DEVELOPMENT SCHEDULE (I1)
3. DEVELOPMENT BUDGET (I7)
4. PROJECTED USER REQUIREMENTS (I2)
5. GROWTH AND EVOLUTION PLAN (I1)
6. APPROVED CCB PRODUCTS (I1)
7. I/F STANDARDS (I1)
8. DATA SYSTEMS & UTILIZATION POLICIES (P1)

1. INFORMATION & NETWORK SYSTEM CAPABILITY ENHANCEMENT SPECIFICATIONS (E7,E9)
2. ENGINEERING CHANGE REQUESTS (ECRs) (I1)
3. COST ESTIMATES (I1)
4. IMPACT ASSESSMENTS (I1)
5. GROUND NETWORK ARCHITECTURE DEFINITION DOCUMENT
6. DEVELOPMENT SCHEDULES (I1)

1. Perform enhancement feasibility and supportability analyses. (2.1.1, 2.4.1) Develop subsystem specification and performance requirements.

2. Manage/perform advanced information and network system development programs. (2.1.1)

3. Provide engineering expertise for anomaly resolution.

4. Develop engineering change requests (ECRs).

5. Provide cost estimates for proposed system enhancements. (5.4.3)

6. Provide impact assessments for proposed system enhancements. (2.3.2,2.3.3)

7. Develop and control the ground network architecture definition document. Establish external interfaces necessary to coordinate and manage this funtional area.

8. Preparation and management of development programs, schedules.

## SPACE STATION
## PROGRAM INTEGRATION FUNCTIONS & PRODUCTS

### SAFETY, RELIABILITY/ MAINTAINABILITY & QUALITY ASSURANCE
### I6

1. SAFETY REQUIREMENTS & DIRECTIVES (P5)
2. USER SYSTEMS DESIGNS (I2)
3. PROPOSED SYSTEMS CONFIGURATION AND OPERATIONS CONCEPT CHANGES (I1,I9,E1)
4. USER ICDs (I2)
5. SYSTEM ICDs (I3,I4)

1. USER SAFETY STANDARDS (I2)
2. SAFETY ASSESSMENTS FOR ALL SPACE STATION FLIGHT SYSTEMS (I1)
3. SAFETY ASSESSMENTS FOR ALL USER SYSTEMS (I2)

1. Perform safety assessments of Space Station flight systems.

2. Assess the safety of user systems, the user-to-system interfaces, and the user's proposed transaction management approach. (1.2.5)

3. Provide independent reviews, analyses, and reports on proposed system configuration and operations concept changes. (5.1.11)

## SPACE STATION
## PROGRAM INTEGRATION FUNCTIONS & PRODUCTS

BUDGET
ADMINISTRATION &
COST CONTROL
I7

1. OPERATIONS BUDGETS (P6)
2. DEVELOPMENT BUDGETS (P6)
3. EXPENDITURE REPORTS/OPERATIONAL VARIANCES (I1,E1,E3)

1. OPERATIONS BUDGETS (I1,E1,E3)
2. DEVELOPMENT BUDGETS (I3,I4,I5)
3. BUDGET REQUESTS (P1)
4. FUNDING ALLOCATIONS (ALL)

1. Develop budget schedules. (5.4)

2. Distribute funds and assign controls. (5.4)

3. Administer budget. (5.4)

## SPACE STATION
## PROGRAM INTEGRATION FUNCTIONS AND PRODUCTS

INTEGRATED
LOGISTICS SYSTEMS
I8

1. RESUPPLY/RETURN REQUIREMENTS (I3,I4)
2. LOGISTICS REQUIREMENTS (I1)
3. USER ACCOMMODATION REQUIREMENTS (I2)

1. MATERIAL REQUIREMENTS (E6)
2. INTEGRATED LOGISTICS INPUTS TO TOP PLANNING PROCESS (I1)
3. LOGISTICS SUPPORT PLANS (I1)

1. Formulate plans for the use and procurement of integrated logistics facilities. (4.5)

2. Develop and plan for logistics engineering capability. (4.1,4.9)

3. Analysis of Station/platform resupply requirements to aid in tactical operations planning. (4.1)

4. Perform logistics support planning, coordination, analysis and integration. (4.1)

5. Analysis of current user payload logistics support requirements, Station real-time problem/resolution impacts, to develop logistics support requirements for the next 16 flight increments. (4.1)

6. Develop plans for maintenance integration.

## SPACE STATION
## PROGRAM INTEGRATION FUNCTIONS AND PRODUCTS

**CONFIGURATION CONTROL**
**I9**

1. ECR IMPACTS, ASSESSMENTS AND RECOMMENDATIONS (I3,I4,E1)
2. TOP CHANGE REQUESTS (I1-B)
3. SYSTEM HARDWARE CHANGE REQUESTS (I1-B,E1,E2,...)

1. INTEGRATED SYSTEMS SPECIFICATION
2. CONFIGURATION BASELINE LIST (I2,I6,E1,E3,P8)
3. CHANGE APPROVALS (I1-B,E1,E2,...)

1. Conduct system flight readiness reviews (FRRs).

2. Manage changes to the baseline system through a formal review and approval process prior to directing hardware and software changes.

3. Conduct periodic reviews and audits to verify that the change control process is effective.

4. Establish and maintain a data collection and storage system which provides for tracking the change control documentation. These include change requests, dispositions, actions for change request, and verification reports. (2.3.2,2.3.3)

## SPACE STATION
## PROGRAM INTEGRATION FUNCTIONS AND PRODUCTS

NOTE: This is not a Station organization function!

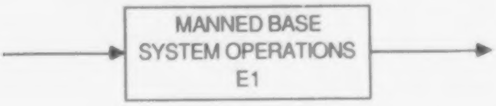
**UTILIZATION STEERING COMMITTEE**
**I10**

1. MANIFEST OPTIONS (I1-A.1)

1. PAYLOAD-TO-INCREMENT ASSIGNMENT SUPPORT (I1-A.1)
2. RECOMMENDATIONS AS TO ASSIGNMENT CHANGES (I1-A.1)
3. DECISION ASSISTANCE IN BORDERLINE SITUATIONS (I1-A.1)

1. A user working group function concerned with the analysis of possible payload-to-increment assignments. Makes recommendations based upon the assignment desirability from a user standpoint.

## SPACE STATION
## PROGRAM EXECUTION FUNCTIONS & PRODUCTS



1. SSIS OPS PLAN (E7)
2. FLIGHT INCREMENT PLAN (I1)
3. CONFIGURATION, GROWTH, & EVOLUTION PLAN (I9,I1)
4. SYSTEM ICDs AND PAYLOAD OPERATION/INTEGRATION ANNEXES (I2)
5. CRITICAL PATH SCHEDULE OF INCREMENT PREPARATION ACTIVITIES (I1)

1. WEEKLY RESOURCE ALLOCATION SCHEDULES & DAILY CAPs (E2)
2. CREW TECHNIQUES AND PROCEDURES FOR OPERATING STATION SYSTEMS & USER SUPPORT EQUIPMENT
3. TRAFFIC MANAGEMENT PROCEDURES
4. OPS WORKSTATION (OWS) PROCEDURES
5. EXT. MAINT & SERVICING FACILITY (EMSF) PROCEDURES
6. COMMON SYSTEM REQUIREMENTS (I1)
7. PROVISIONING REQUIREMENTS (I1)
8. PROPOSED SYSTEMS CONFIGURATION AND OPERATIONS CONCEPT CHANGES (I9)
9. USER RESOURCE TEMPLATES (E2)

1. Design, planning and development of flight operations for a specified period of time. (2.2.1)
2. Operations planning and scheduling. (2.2.2)
3. Crew procedures and techniques. (2.2.4)
4. Ground procedures and techniques. (2.2.5)
5. Support systems preparation. (2.2.9)
6. Operations facilities support. (2.1.1, 2.1.2, 2.1.3)
7. Flight operations support. (2.3.1)
8. Data storage and data base design, operation, and maintenance. (2.3.2 modified)
9. Operations support reconfiguration. (2.3.4)
10. Technical data and documentation. (4.3)
11. Operations working group activities. (5.3.3)
12. Operations support to engineering simulations. (5.3.4)
13. Station/user systems physical integration. (1.3.6)
14. Development of preflight and real-time user resource templates.

## SPACE STATION
## PROGRAM EXECUTION FUNCTIONS & PRODUCTS

MANNED BASE USER
OPERATIONS
SUPPORT
E2

1. RESOURCE ALLOCATION TEMPLATES (E1)
2. KEY RESOURCE PARAMETERS (E1)
3. DISCIPLINE OPS PLAN
4. DETAILED USER PLANS
5. CURRENT DAILY STATION STATUS (E1)
6. USER REQUIREMENTS
7. DAILY UPDATED RESOURCE ALLOCATIONS (E1)

1. INTEGRATED PAYLOAD MISSION PLAN (E1)
2. RESOURCE RQMTS DELTAS (E1)
3. RESOURCE ALLOCATIONS AND PLANS (USERS)
4. PAYLOAD CREW ACTIVITY PLAN (E1)
5. DAILY RESOURCE ALLOCATION UPDATES (USERS)

1. Develop Integrated Payload Mission Plan as input to Ops Programming Tactical Plan.

2. Generate the Summary Payload CAP.

3. Update discipline allocations based upon system capabilities.

4. Integrate payload user detailed procedures and command plans into PCAP.

5. Review daily performance parameters, assess PCAP and update with IWG approval the user resource allocations.

6. Verify adherence to safety requirements by users, assist in troubleshooting problems, enable user command and voice uplink, real-time conflict resolution. (1.4.4)

7. Execution of user operations. (1.4.4)

8. Define and update payload operations requirements.

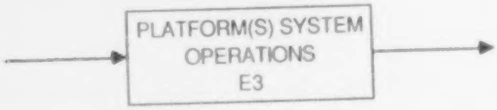
9. Work with DOC to resolve conflicts or appeal to IWG or POIC concerning resource allocation issues.

10. Allocate resources to Users. (1.4.4)

11. Provide an integrated assessment of user requirements based on revised daily activity plans from users. (1.4.4)

12. Represents users to the POIC for planning activities. (1.4.4)

## SPACE STATION
## PROGRAM EXECUTION FUNCTIONS & PRODUCTS

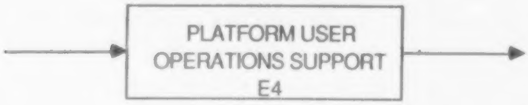


1. SSIS OPS PLAN (E7)
2. PLATFORM OPERATIONS PLAN (I1)
3. CONFIGURATION, GROWTH & EVOLUTION PLAN (I9,I1)
4. SYSTEM ICDs AND PAYLOAD OPERATION/INTEGRATION ANNEXES (I2)

1. WEEKLY RESOURCE ALLOCATION SCHEDULES (E4)
2. COMMON SYSTEMS REQUIREMENTS (I1)
3. TRAFFIC MANAGEMENT PROCEDURES
4. USER RESOURCE TEMPLATES (E4)

1. Design, planning, and development of flight operations for a specified period of time. (2.2.1)
2. Operations planning and scheduling. (2.2.2)
3. Ground procedures and techniques. (2.2.5)
4. Support systems preparation. (2.2.9)
5. Operations facilities support. (2.1.1, 2.1.2, 2.1.3)
6. Flight operations support. (2.3.1)
7. Data storage and data base design, operation, and maintenance. (2.3.2 modified)
8. Operations support reconfiguration. (2.3.4)
9. Technical data and documentation. (4.3)
10. Operations working group activities. (5.3.3)
11. Operations support to engineering simulations. (5.3.4)
12. Platform/user systems physical integration. (1.3.6)

## SPACE STATION
## PROGRAM EXECUTION FUNCTIONS & PRODUCTS



1. USER INSTRUMENT SCIENCE OPERATIONS REQUIREMENTS (USERS)
2. SCIENCE/MISSION GUIDELINES
3. RESOURCE ALLOCATIONS (E3)
4. INTEGRATED PLATFORM TACTICAL OPERATIONS PLAN (I1)
5. INSTRUMENT/SCIENCE SCHEDULING REQUIREMENTS
6. DETAILED INSTRUMENT TIMELINES
7. REVISIONS AS NEEDED TO INTEGRATED PLATFORM TOP

1. INSTRUMENT/SCIENCE ALLOCATIONS
2. INTEGRATED SCIENCE PLAN
3. SCIENCE SCHEDULING TEMPLATE
4. INTEGRATED TRANSFER OPS REQUIREMENTS (E1)
5. PLATFORM SERVICING MAINTENANCE PLANNING INPUTS (E1)
6. NON-PROXIMITY ZONE TRANSFER OPS PLANNING INPUTS (E1)

1. Monitor platform performance and maintain the onboard systems configuration.

2. Manage onboard systems to maintain system integrity and safety.

3. Respond to platform contingencies by developing plans and procedures for restoring the platform to normal operations.

4. Provide the focal point for leading anomaly investigations supported by the ESCs.

5. Schedule system operations by integrating instrument data acquisition requirements, producing activity timelines, and transmitting timelines in the form of command files to the platform.

6. Provide the direction for the development of malfunction procedures by the ESCs to support platform troubleshooting and checkout operations.

7. Provide the lead to the Software Development Facility (SDF) for the development and implementation of onboard system software updates.

8. Coordinate the platform payload operations activities performed in support of the UOFs such as the acquisition and distribution of platform and instrument data. (1.4.4)

9. Coordinate the platform payload operations activities performed by other supporting ground elements such as the Flight Dynamics Facility, the Network Control Center and NASCOM.

10. Analyze, process, and display platform engineering data.

11. Maintain platform histories, configurations, and system performance measurements.

12. Perform platform anomaly analysis and recommend procedural corrective actions.

13. Develop maintenance and servicing ORU changeout and repair recommendations and procedures.

14. Develop post-maintenance verification and checkout procedures.

15. Support logistics and resupply activities.

16. Maintain instrument health and safety, monitor instrument telemetry, analyze instrument performance.

17. Plan and perform instrument operations, develop instrument operating timelines, generate and uplink instrument command sequences, update instrument operation procedures.

18. Capture, process, archive, and analyze instrument telemetered data.

19. Generate reports and scientific data products.

20. Monitor platform performance and maintain the onboard system configuration during transfer operations.

21. Provide the focal point for leading servicing and maintenance activities supported by the ESCs.

22. Develop the coordinated operations requirements for the cooperating transfer operations elements.

23. Schedule transfer operations activities, produce activity timelines and transmit timelines in the form of command files to the platform.

24. Process, store, and distribute platform data.

25. Monitor the operation and performance of cooperating elements.

26. Coordinate transfer operations performed by other ground elements.

27. Manage the handover of platform operations control between transportation and mission operators.

# SPACE STATION
# PROGRAM EXECUTION FUNCTIONS & PRODUCTS

## PREFLIGHT/POSTFLIGHT OPERATIONS
## E5

1. FLIGHT INCREMENT PLANS (I1)
2. SYSTEM ICDs AND PAYLOAD INTEGRATION ANNEXES (I2)
3. SSIS OPS PLAN (E7)
4. CRITICAL PATH SCHEDULE OF INCREMENT PREPARATION ACTIVITIES (I1)

1. ASSEMBLY/DISASSEMBLY PROCEDURES
2. MOVEMENT/LOADING/UNLOADING PROCEDURES
3. VERIFICATION, TEST, AND CHECKOUT PROCEDURES
4. SERVICING AND DESERVICING PROCEDURES
5. TOXIC/HAZARDOUS MATERIALS HANDLING PROCEDURES
6. FLIGHT SUPPORT EQUIPMENT INTEGRATOIN PROCEDURES
7. PROPRIETARY EQUIPMENT PROTECTION PROCEDURES
8. MASS PROPERTIES MANAGEMENT
9. POST-TEST DATA PROCESSING PROCEDURES
10. SECURITY PROCEDURES
11. CREW SUPPORT PROCEDURES
12. SSPF STORAGE AND MAINTENANCE PROCEDURES
13. HAZARDOUS OPERATING PROCEDURES
14. DATA PROCESSING AND STORAGE PROCEDURES
15. FINAL MASS PROPERTIES DATA
16. PRIME AND CONTINGENCY SITE POST LANDING OPS PLAN
17. FACILITIES AND EQUIPMENT ROMTS DOCUMENT
18. INTEGRATED USER ELEMENT TEST PROCEDURE DEVELOPMENT SUPPORT
19. HARDWARE DELIVERY SCHEDULES FOR PRELAUNCH PROCESSING
20. MULTIFLOW MANAGEMENT SCHEDULES FOR PRELAUNCH PROCESSING

1. Responsible for real-time execution of pre-increment ground operations. Areas of activity include payload processing, configuration, test and checkout, transportation as they relate to the following areas:
(a). Experiment integration (3.1.1)
(b). Structures/Systems (3.1.2)
(c). Laboratory modules (3.1.3)
(d). Habitation modules (3.1.4)
(e). Logistics carriers (3.1.5)
(f). Orbital maneuvering vehicle (3.1.6)
(g). Platforms (3.1.7)
(h). International element support. (3.1.8)

2. Responsible for ground system maintenance. (3.1.9)

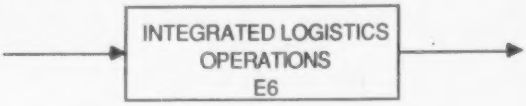
3. Operations planning and analysis. (3.3)

4. Payload/payload facility support. (3.4)

5. Technical data and documentation. (4.3)

6. Test, verification, and assembly operations.

## SPACE STATION
## PROGRAM EXECUTION FUNCTIONS & PRODUCTS



1. FLIGHT INCREMENT PLANS (I1)
2. GROWTH & EVOLUTION PLAN (I1)
3. CRITICAL PATH SCHEDULE OF INCREMENT PREPARATION ACTIVITIES (I1)

1. SHIPPING/RECEIVING PROCEDURES
2. LRU MAINTENANCE & REPAIR PROCEDURES
3. HARDWARE IMPACT REFURBISHMENT PROCEDURES
4. FLIGHT AND GROUND HARDWARE CALIBRATION PROCEDURES
5. GROUND TRANSPORTATION REQUIREMENTS
6. REPAIR LEVEL ANALYSES
7. INVENTORY MANAGEMENT SYSTEM OPS PROCEDURES
8. MAINTENANCE WORK AREA (MWA) PROCEDURES
9. TRAINING/SIMULATOR FACILITY REQUIREMENTS (I1)

1. Maintenance for ground and space based equipment in operational condition. (4.2)

2. Technical data and documentation. (4.3)

3. Logistics facilities maintenance and operations. (4.5)

4. Packaging, handling, storage, and ground transportation. (4.6)

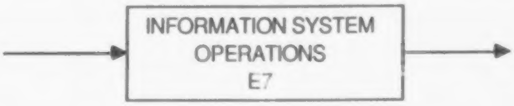
5. Personnel and training. (4.7)

6. Ground Support Equipment acquisition. (4.8)

7. Repair management for space and ground system Orbital Replacement Units (ORUs).

8. Resupply/Return management.

## SPACE STATION
## PROGRAM EXECUTION FUNCTIONS & PRODUCTS



1. INTERFACE STANDARDS (I1)
2. FLIGHT INCREMENT PLANS (I1)
3. CAPABILITY ENHANCEMENT SPECS FOR STATION & PLATFORMS (I5)
4. CAPABLITY ENHANCEMENT SPECS FOR GROUND SEGMENTS (I5)
5. SYSTEM ICDs AND PAYLOAD INTEGRATION ANNEXES (I2)
6. SSIS OPS PLAN (I2)
7. DESIGN AND ENGINEERING DATA ON GROUND SEGMENT EHNANCEMENTS/MODIFICATIONS (E8)

1. ICD INPUTS (I2)
2. SSIS OPS PLAN (E1,E3,E5)

1. Network requirements integration in preparation for flight increment operations. (2.3.3)

2. Pre-increment and real-time information systems operations support to Station Systems Support Center (SSSC), Payload Operations Integration Center (POIC), and users. (2.3.2)

3. Development and maintenance of the Space Station Information System (SSIS) Operations Plan. (2.3.2,2.3.3)

4. Information systems support to non-real-time facilities (Policy, Integration levels), real-time input to information systems planning, data sharing, storage, etc.

## SPACE STATION
## PROGRAM EXECUTION FUNCTIONS & PRODUCTS

### SUSTAINING ENGINEERING: SPACE SYSTEMS
### E8-A

1. STATION AND PLATFORM CAPABILITY ENHANCEMENT SPECIFICATIONS (I3,I4)
2. GROWTH AND EVOLUTION EVALUATION REQUESTS (P4)
3. INTERFACE STANDARDS (I1)
4. PAYLOAD INTEGRATION ANNEXES (I2)
5. DEVELOPMENT SCHEDULES (I3,I4)
6. STATION/PLATFORM SYSTEMS PERFORMANCE EVALUATIONS (E1,E3)

1. DESIGN AND ENGINEERING DATA ON STATION AND PLATFORM
2. ORU MAINTENANCE PROCEDURES
3. MAINTENANCE DIAGNOSTIC PROCEDURES
4. SYSTEM PERFORMANCE EVALUATIONS (E1,P5)
5. ENGINEERING CHANGE REQUESTS (ECRs) (I1)
6. ENGINEERING ASSESSMENTS (I1)
7. PERFORMANCE DEGRADATION ANALYSES (E1)
8. STATION/PLATFORM HARDWARE INTERFACE CONTROL DOCUMENTS (ICDs) (I3,I4)
9. FLIGHT ELEMENT TO LAUNCH VEHICLE ICDs (P7)
10. INTERELEMENT ICDs (I3,I4)
11. PREVENTATIVE MAINTENANCE REQUIREMENTS (I1)
12. GROWTH AND EVOLUTION PLAN EVALUATIONS (P4)

1. Design and engineering of Station and platform enhancements/modifications. (2.1.1, 2.4.2)

2. Support the feasibility and supportability analyses of proposed enhancements and modifications. (2.1.1, 2.4.1)

3. Subsystem integration and verification. (2.4.4)

4. Perform Station system advanced technology programs (as assigned). (2.1.1)

5. Station reconfiguration and payload installation requirements. Includes schematics, installation/removal instruction and software products.

6. Modification/enhancement implementation. (2.4.3)

7. Provide engineering expertise for anomaly resolution.

8. Provide analyses of degradations of performance and windows. (SSORD 3.1.4.2.3)

9. Maintain and update Station/platform hardware ICDs.

10. Engineering support analysis for loads, mass, RF, and thermal, for Station elements.

11. Analysis of current Station maintenance status, and subsequent issue of periodic Station preventative maintenance requirements and procedural details to Station Operations and Maintenance Planning function.

## SPACE STATION
## PROGRAM EXECUTION FUNCTIONS & PRODUCTS

### SUSTAINING ENGINEERING: GROUND SYSTEMS
### E8-B

1. CAPABILITY ENHANCEMENT SPECIFICATIONS GROUND SEGMENT (I3,I4)
2. INTERFACE STANDARDS (I1)
3. PAYLOAD INTEGRATION ANNEXES (I2)
4. DEVELOPMENT SCHEDULES (I3,I4)

1. DESIGN AND ENGINEERING DATA ON GROUND SEGMENT ENHANCEMENT/MODIFICATIONS
2. ENGINEERING CHANGE REQUESTS (ECRs) (I1)
3. ENGINEERING ASSESSMENTS (I1)
4. PREVENTATIVE MAINTENANCE REQUIREMENTS (I1)

1. Design and engineering of ground segment enhancements/modifications. (4.5, 2.1.1, 2.4.2)

2. Maintenance of interfacing ground support equipment.

3. Maintenance and development of non-interfacing ground systems, including console equipment, simulators/trainers, payload integration and verification facilities, etc.

## SPACE STATION
## PROGRAM EXECUTION FUNCTIONS & PRODUCTS

**SUSTAINING ENGINEERING: PAYLOAD INTERFACE ENGINEERING & INTEGRATION**
**E8-C**

1. USER INTERFACE DESIGN REQUESTS (I2)
2. INTERFACE STANDARDS (I1)
3. PAYLOAD INTEGRATION ANNEXES (I2)
4. DEVELOPMENT SCHEDULES (I3,I4)
5. USER ICDs (I2)

1. USER ICD INPUTS (I2)
2. USER-SYSTEM I/F DESIGN (I2)
3. ENGINEERING CHANGE REQUESTS (ECRs) (I1)
4. ENGINEERING ASSESSMENTS (I1)
5. INTEGRATED PLAN ENGINEERING ANALYSES (I1-A)

1. User-system interface engineering. Includes user-system interface designs as requested/necessary. (1.3.5)

2. User-system/subsystem integration, verfication, and compatibility assessments. (1.3.1)

3. Station reconfiguration and payload installation requirements. Includes schematics, installation/removal instruction and software products.

4. Provide engineering expertise for anomaly resolution.

5. Engineering support analysis for loads, mass, RF, and thermal, for payload elements.

6. Performance of plan engineering analyses for Integrated Operations Planning function to aid in optimization, tradeoffs, and conflict resolution in the integration of Station and Payload Support Plans.

## SPACE STATION
## PROGRAM EXECUTION FUNCTIONS & PRODUCTS

**CONFIGURATION MANAGEMENT: SPACE SYSTEMS**
**E9-A**

1. HARDWARE ACCEPTANCE DATA PACKAGES
2. SOFTWARE DELIVERABLE DATA PACKAGES
3. INTERFACE CONTROL DOCUMENTS
4. INTERFACE REVISION NOTICES (IRNs)
5. SYSTEM REQUIREMENT REVIEWS
6. PRELIMINARY DESIGN REVIEWS
7. CRITICAL DESIGN REVIEWS

1. DESIGN IMPLEMENTATION PLANS
2. SPECIFICATION TREE
3. CONTRACT CHANGE ORDERS
4. CHANGE STATUS REPORTS
5. DESIGN BASELINE (ENGINEERING DRAWINGS)
6. SYSTEM CERTIFICATION (SAFETY/ENVIRONMENTAL)
7. DESIGN REVIEW RESULTS
8. INSTALLATION NOTICE OF COMPLETION
9. AS-INSTALLED CONFIGURATION STATUS REPORT
10. MODIFICATION STATUS

1. Selecting end items of hardware and software to come under configuration control.

2. Develop and maintain baseline identification of hardware and software under configuration control. (2.3.4)

3. Develop and maintain engineering documentation.

4. Control hardware and software such that demonstrated physical status and performance satisfy mission, safety, and security requirements.

5. Closing out configuration change directives upon completion of the configuration verification and configuration accounting processes.

6. Conduct reviews to assure that the design of the changes to the baseline configuration satisfies approved requirements (mission, safety, security,...).

7. Conduct reviews, tests, inspections, etc., to assure that the hardware or software end items conform to the released design documentation.

8. Conduct reviews, tests, inspections, etc., to assure that the modifications have been incorporated in accordance with the configuration change directive (i.e. verify "as-built" is the same as "as-designed").

## SPACE STATION
## PROGRAM EXECUTION FUNCTIONS & PRODUCTS

### CONFIGURATION MANAGEMENT: GROUND SYSTEMS
### E9-B

1. HARDWARE ACCEPTANCE DATA PACKAGES
2. SOFTWARE DELIVERABLE DATA PACKAGES
3. INTERFACE CONTROL DOCUMENTS
4. INTERFACE REVISION NOTICES (IRNs)
5. SYSTEM REQUIREMENT REVIEWS
6. PRELIMINARY DESIGN REVIEWS
7. CRITICAL DESIGN REVIEWS

1. DESIGN IMPLEMENTATION PLANS
2. SPECIFICATION TREE
3. CONTRACT CHANGE ORDERS
4. CHANGE STATUS REPORTS
5. DESIGN BASELINE (ENGINEERING DRAWINGS)
6. SYSTEM CERTIFICATION (SAFETY/ENVIRONMENTAL)
7. DESIGN REVIEW RESULTS
8. INSTALLATION NOTICE OF COMPLETION
9. AS-INSTALLED CONFIGURATION STATUS REPORT
10. MODIFICATION STATUS

1. Selecting end items of hardware and software to come under configuration control.

2. Develop and maintain baseline identification of hardware and software under configuration control. (2.3.4)

3. Develop and maintain engineering documentation.

4. Control hardware and software such that demonstrated physical status and performance satisfy mission, safety, and security requirements.

5. Conduct reviews, tests, inspections, etc., to assure that the hardware or software end items conform to the released design documentation.

6. Conduct reviews, tests, inspections, etc., to assure that the modifications have been incorporated in accordance with the configuration change directive (i.e. verify "as-built" is the same as "as-designed").

## SPACE STATION
## PROGRAM EXECUTION FUNCTIONS & PRODUCTS

### CONFIGURATION MANAGEMENT: PAYLOAD INTERFACES
### E9-C

1. PAYLOAD-TO-STATION ICDs/ANNEXES (I2)
2. PAYLOAD-TO-STATION ICD/ANNEX CHANGE REQUESTS (I2)

1. CHANGE REQUEST APPROVALS/DISAPPROVALS (I2)

1. Maintain configuration control of payload-to-Station/platform ICDs and Annexes.

2. Determine the appropriate level of change control for all payload-to-Station/platform interface documentation.

3. Determine when payload to Station/platform interface documentation goes under change control.

## SPACE STATION
## PROGRAM EXECUTION FUNCTIONS & PRODUCTS

### CONFIGURATION MANAGEMENT: EXECUTION-LEVEL OPS PLANS & PROCEDURES
### E9-D

1. FLIGHT DATA FILE (E1)
2. OMSRDs (E5)
3. OMIs (E5)
4. CHANGE REQUESTS

1. CHANGE REQUEST APPROVALS/DISAPPROVALS (I1-B)

1. Maintain configuration control over Station flight data file, Operations and Maintenance Specifications Requirements Documents (OMSRDs), and Operational Maintenance Instructions (OMIs).

2. Determine the appropriate level of control for the above documents.

3. Determine when the above documents go under change control.

## SPACE STATION
## PROGRAM EXECUTION FUNCTIONS & PRODUCTS

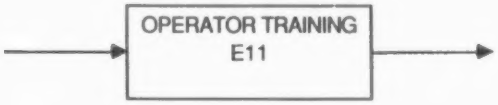
### SAFETY, RELIABILITY/ MAINTAINABILITY & QUALITY ASSURANCE
### E10

1. LAUNCH SITE OPERATIONS (E5)
2. LOGISTICS OPERATIONS PLANS (E6)
3. FLIGHT OPERATIONS SUPPORT PLANS (E1,E2,E3,E4)

1. LAUNCH SITE SR/M&QA PROCEDURES (E5)
2. LOGISTICS SUPPORT SR/M&QA PROCEDURES (E6)
3. GROUND OPERATIONS SR/M&QA PLAN (E5,E7)
4. FLIGHT OPERATIONS SAFETY ASSESSMENTS (E1,E2,E3,E4)

1. Implements and ensures execution level compliance with the safety, reliability/maintainability and quality assurance policies and requirements of the Space Station.

## SPACE STATION
## PROGRAM EXECUTION FUNCTIONS AND PRODUCTS



| | |
|---|---|
| 1. CREW, FLIGHT CONTROLLER TRAINING REQUIREMENTS (I1) | 1. CREW, FLIGHT CONTROLLER TRAINING PLANS (I1) |
| 2. GROUND SUPPORT OPERATIONS TRAINING REQUIREMENTS (I1) | 2. GROUND SUPPORT OPERATIONS TRAINING PLANS (I1) |
| 3. SPACE AND GROUND OPERATIONS SCHEDULES (I1) | |
| 4. TRAINING FACILITY AVAILABILITIES | |
| 5. PERSONNEL SKILL REQUIREMENTS (I1) | |

1. Analysis of Station and ground personnel training requirements and schedules for development of appropriate training plans and procedures. (2.2.7)

2. Organization and scheduling of inter-facility training activities such as large-scale simulations, dry runs, etc. (2.2.7)

3. Executes crew, flight controller, ground support personnel training plans. (2.2.8)

# APPENDIX C

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# APPENDIX C

## BASELINE PROGRAM FACILITIES ASSESSMENT

The facility listing in this Appendix was originally compiled by the Level B Space Station Program Office as a working tool in defining the required facilities to support Space Station assembly and development. It was anticipated that this list would be used to relate the development work being performed within the various NASA Centers to work conducted by their prime contractors as part of an effort to avoid duplication and overlap of facilities in the Development Phase of the Program.

However, as a better definition of annual operations costs was formulated by the Program, this list was expanded to include all of the projected facilities required for both development and subsequent mature operations. In this manner, it is hoped that early scrutiny of the facilities planned for use in the Development Phase could result in an established plan for phasing out any which will not be required during Mature Operations. Similarly, early identification of facility requirements for mature operations could help find areas of synergy with currently planned development facilities which would optimize Program resources.

The SSOTF conducted a limited review of this augmented list and categorized the facilities into three groups: (1) those which were mandatory for Station operations under the SSOTF Recommended Framework; (2) those whose operational functions were either not well understood or would be required on an as needed basis only; and (3) those which would not be required at all during the Mature Operations Phase. This grouping was then subdivided into Space Station unique facilities, and facilities which would be shared with other programs in an effort to more accurately scope the size of the facilities support burden required to run the Station Program.

Given the limited amount of time and information available to its members, this review is only a preliminary effort at identifying the full extent of facilities requirements for the Program. The Task Force recommends that the Space Station Program initiate further study of the projected facility support requirements and their associated opertional costs to determine exact areas of overlap and synergy in planned facilities.

### Space Station Program Evaluation
### Facility/Capability all Program Phases
### Working Paper

| FACILITIES/CAPABILITIES | FACILITY DESCRIPTIONS | WP |
|---|---|---|
| MANDATORY - SPACE STATION UNIQUE | | |
| SOFTWARE SUPPORT ENVIRONMENT (SSE) | FOR DEVELOPMENT OF TOOLS AND RULES FOR SS SOFTWARE | A' |
| SERVICE & VERIF FACILITY | MOCKUP DELIVERABLE FROM WP4 PRIME | GSFC |
| S/W PRODUCTION FACILITY | FACILITY TO PRODUCE OR VERIFY APPLICATIONS S/W | GSFC |
| ENGINEERING ANALYSIS FACILITY (CDOS) | ENGINEERING DATA ANALYSIS SUPPORT TO CDOS | GSFC |
| INTEG. TEST & VERIFICATION FACILITY | EXPERIMENT INTEGRATION & CHECKOUT FACILITY | GSFC |
| PLATFORM SUPPORT CENTER (CDOS) | CONTROL FACILITY FOR PLATFORMS | GSFC |
| SERVICING SUPPORT CENTER (CDOS) | CONTROL ROOM FOR SERVICING FACILITY | GSFC |
| SPACE STATION TRAINING FACILITY (SSTF) | PRIMARY CREW & CONTROLLER TRAINING FACILITY | JSC |
| STATION PROXIMITY OPERATIONS TRAINER | USED FOR RENDEZVOUS/PROX OPS/MRMS OPERATIONS TRAINING | JSC |
| MEDIUM FIDELITY LAB MODULE SIMULATORS | LAB SYSTEMS/PAYLOADS TRAINER | JSC |
| FLIGHT CONTROLLER TRAINING FACILITY | PROVIDE TRAINING ENVIRONMENT FOR CONTROLLERS | JSC |
| SPACE STATION SYSTEMS TRAINER | DISTRIBUTED SYSTEMS TRAINER | JSC |
| MULTI-SYSTEMS INTEGRATION FACILITY (MSIF) | PERFORM INTEGRATION AND VERIFICATION OF SYSTEMS S/W | JSC |
| MANNED AND MANIPULATOR SYS INTEG TESTBED | MANNED RMS/MRMS SYSTEMS INTEG & MOCKUPS | JSC |
| TAVERNS | PROTOTYPE/TESTBED FOR DMS/DMS DEVELOPMENT | JSC |
| SPACE STATION SUPPORT CENTER (SSSC) | PRIMARY SYSTEMS/FLIGHT CONTROL CENTER | JSC |
| SS AUTOMATION INTEG & ASSEMBLY FACILITY | STRUCTURES AND MECHANISMS LABORATORY | JSC |
| S/W PRODUCTION FACILITY | FACILITY TO PRODUCE OR VERIFY APPLICATIONS S/W | JSC |
| SPACE STATION PROCESSING FACILITY (SSPF) | DEDICATED HORIZONTAL PROCESSING FACILITY | KSC |
| S/W PRODUCTION FACILITY | FACILITY TO PRODUCE OR VERIFY APPLICATIONS S/W | KSC |
| * MODS TO SSPF: MASTER INTEGRATION FACILITY | ENHANCEMENT OF TEST/CHECKOUT CAPABILITY IN SSPF | KSC |
| * LOGISTICS OPS CENTER | FACILITY TO STOCK, REPAIR, SUPPORT LOGISTIC FUNCTION | KSC |
| S/W PRODUCTION FACILITY | FACILITY TO PRODUCE OR VERIFY APPLICATIONS S/W | LERC |
| OPS SUPT CNTR. (ESC) | ENGINEERING SUPPORT CENTER FOR POWER SYSTEMS (WP4) | LERC |
| PAYLOAD TRAINING INTEGRATION FACILITY (PTIF) | SIMULATOR USED FOR PRE-INCREMENT CREW TRAINING | MSFC |
| * PAYLOAD OPERATIONS INTEGRATION CENTER (POIC) | PRIMARY USER OPERATIONS INTEGRATION CENTER | MSFC |
| GROUND CONTROL EXPERIMENT LAB (GCEL) | FOR VERIFICATION/CHECKOUT OF SS EXPERIMENT EQUIPMENT | MSFC |
| I/F VERIF/SIMULATION FACILITY | SUPPORTS I/F VERIFICATION FOR RACKS OF USER EQUIPMENT | MSFC |
| ONE G MOCKUP (OPS DEVELOPMENT COMPLEX) | MOCKUP OF THE MODULES AND NODES | MSFC |
| S/W PRODUCTION FACILITY | FACILITY TO PRODUCE OR VERIFY APPLICATIONS S/W | MSFC |
| CORE MOD INTEG. FAC/CORE MODULE SIM. FAC | CORE MODULE INTEGRATED SYSTEM SIMULATOR | MSFC |

## Space Station Program Evaluation
## Facility/Capability all Program Phases
## Working Paper (Continued)

### MANDATORY - SHARED WITH OTHER PROGRAMS

| | | |
|---|---|---|
| MISSION CONTROL CENTER (MCC-H) | SHUTTLE CONTROL CENTER | JSC |
| SHUTTLE MISSION SIMULATOR (SMS) | SHUTTLE MISSION SIMULATOR USED FOR JOINT OPERATIONS | JSC |
| EMU TRAINER | EVA/SUIT TRAINER | JSC |
| DATA HANDLING CENTER (CDOS) | PART OF THE CUSTOMER DATA OPS SYSTEM | GSFC |
| WEIGHTLESS ENVIR. TRAINING FACILITY (WETF) | WATER IMMERSION TRAINING FACILITY | JSC |
| SYSTEMS ENG. SIMULATOR-STATION ON-ORBIT SIMS | SHUTTLE ENG. SIMULATOR FOR STS/SS OPS SIMULATIONS | JSC |
| VLS P/L PROCESSING FACILITY | VANDENBURG LAUNCH SITE PAYLOAD PROCESSING FACILITY | KSC |
| MODS TO PADS A&B | MODIFICATIONS TO LAUNCH PADS ALLOWING LATE ACCESS | KSC |
| NEUTRAL BUOYANCY FACILITY | WATER IMMERSION TRAINING FACILITY | MSFC |
| HUNTSVILLE OPERATIONS CENTER (HOSC-MSFC ESC) | WP1 ENGINEERING SUPPORT CENTER | MSFC |

### REQUIRE MORE DATA/USE ON AN AS NEEDED BASIS -SPACE STATION UNIQUE

| | |
|---|---|
| DMS TEST BED | GSFC |
| THERMAL TEST BED | GSFC |
| INTEG. LOGISTICS SYSTEM NODE | GSFC |
| DMS TEST BED | JSC |
| ADVANCED SYSTEMS DEVELOPMENT LAB | JSC |
| USER OPERATIONS FAC | JSC |
| EVA-LIFE SUPPORT SYSTEM TEST BED | JSC |
| EVA TEST BED | JSC |
| C&T/DMS SYSTEM TEST BED | JSC |
| TRACK SYS TEST BED | JSC |
| AC&S SYSTEM TEST BED | JSC |
| THERMAL SYSTEM TEST BED | JSC |
| PROP SYSTEM TEST FACILITY | JSC |
| AUTOMATION TEST BED | JSC |
| ENVIRONMENTAL CONTROL LIFE SUPPORT TEST BED | MSFC |
| ELECTRICAL SYSTEM BREADBOARD | MSFC |
| ECLSS SYSTEM SIMULATOR | MSFC |
| ACS TEST BED | MSFC |
| TEST STAND 300(H/O) | MSFC |

### REQUIRE MORE DATA/USE ON AS NEEDED BASIS - SHARED WITH OTHER PROGRAMS

| | |
|---|---|
| FLIGHT DYNAMICS FACILITY | GSFC |
| LIQUID HELIUM TESTBED | GSFC |
| CONTROL & MONITORING TESTBED | JSC |
| KC-135 | JSC |
| RADIO FREQUENCY COMMUNICATION LAB | JSC |
| THERMAL VACUUM CHAMBERS - NOT MAN RATED | JSC |
| ELECTRO-MAGNETIC INTERFACE TEST FACILITY | JSC |
| ELECTRONIC SYSTEMS TEST LABORATORY (ESTL) | JSC |
| COMM SYS SIM LAB (CSSL) | JSC |
| SYSTEMS OPS DEVELOPMENT LAB | JSC |
| EPDC LAB/TESTBED | JSC |
| GN&C LAB | JSC |
| THERMAL VACUUM - MAN RATED (CHAMBER B) | JSC |
| ANECHOIC CHAMBER | JSC |
| E&D COMPUTATIONAL FACILITY | JSC |
| * COMPUTATIONAL FACILITY | KSC |
| LARGE ATOMIC OXYGEN FACILITY | LERC |
| OPTICS FACILITY | LERC |
| MATERIALS COMPATIBILITY LAB | LERC |
| SOLAR CELL LAB | LERC |
| TANK 5/6 | LERC |
| BATTERY LABS | LERC |
| CMG VAULT | MSFC |
| ATOMIC OXYG BEAM TEST FACILITY | MSFC |
| ON-ORBIT REPAIR FACILITY (PROCESS TECH FAC) | MSFC |
| SPACE ENVIRONMENTAL EFFECTS FACILITY | MSFC |
| MANUFACTURING FACILITY | MSFC |
| OMV/FTS I/F SIMULATOR | MSFC |

## Space Station Program Evaluation
## Facility/Capability all Program Phases
## Working Paper (Continued)

### REQUIRE MORE DATA/USE ON AS NEEDED BASIS - SHARED WITH OTHER PROGRAMS (Continued)

| | |
|---|---|
| SPACE DEBRIS FACILITY | MSFC |
| DYNAMIC TEST STANDS | MSFC |
| ROBOTIC LAB | MSFC |
| MECHANISMS TESTBED/FLAT FLOOR | MSFC |
| MATERIALS PROCESSING SYSTEMS TESTBEDS | MSFC |
| PROPULSION TESTBED | MSFC |

### NOT REQUIRED IN MATURE OPERATIONS - SPACE STATION UNIQUE

| | |
|---|---|
| CUSTOMER COORDINATION CNTR/NODES (CDOS) | GSFC |
| SPACE PROP FACILITY (PLUMBROOK) | LERC |

### NOT REQUIRED IN MATURE OPERATIONS - SHARED WITH OTHER PROGRAMS

| | |
|---|---|
| MULTIPLE APPLICATIONS CONTROL CNTR (CDOS) | GSFC |
| THERMAL VACUUM THERMAL SYSTEMS | JSC |
| SPACE STATION HAZARDOUS PROCESSING FAC (SSHPF) | KSC |
| PAYLOAD OPERATIONS CONTROL CENTER (POCC) | MSFC |
| POCC TRNG B 4755 | MSFC |

* OTF IDENTIFIED REQ

# APPENDIX D

# INDEX OF DEFINITIONS

ACCOMMODATE
AD-HOC
ASSEMBLY
ASTRONAUT
ATTACHED PAYLOADS
AUTOMATION
AUTONOMY
CAPABILITY
CAPACITY
CARGO
CENTRALIZED
CERTIFICATION
CHECKLIST
CHECK-OUT
CO-ORBIT
CO-ORBITING PLATFORMS
COLUMBUS MODULE
COMMAND AND CONTROL ZONE
COMMONALITY
CONCEPT
CONSUMABLES
COSTING
CREW
CREW MEMBER
CUSTOMER
DISCIPLINE OPERATIONS CENTER
DISTRIBUTED SYSTEMS
DOCKING
ENCLAVE
ENGINEERING SUPPORT CENTER
EVOLUTION
EXECUTION (OPERATIONS)
EXPENDABLE LAUNCH VEHICLE (ELV)
EXPENDABLES
EXPERIMENT
EXTRAVEHICULAR ACTIVITY (EVA)
FLIGHT
FLIGHT RULES
FRAMEWORK
GROUND (BASED) OPERATIONS
GROWTH
HEALTH MAINTENANCE FACILITY
IN-SITU
INCREMENT (OPERATIONS)
INFRASTRUCTURE
INITIAL OPERATIONAL CAPABILITY (IOC)
INTEGRATION
INTERNATIONAL PARTNER
INTRAVEHICULAR ACTIVITIES (IVA)
INVESTIGATOR
JAPANESE EXPERIMENT MODULE (JEM)
KIWI
Ku BAND
LABORATORY
LIFE CYCLE COST
LOGISTICS
LOGISTICS OPERATIONS CENTER
MAINTAIN
MAINTAINABILITY
MAINTENANCE
MANIFESTING
MANNED BASE
MATURE OPERATIONS PHASE
MISSION
MISSION SET
MODULE
ORBITAL MANEUVERING VEHICLE
ORBITAL REPLACEMENT UNIT
PARTNER
PAYLOAD
PAYLOAD OPERATIONS
PAYLOAD OPERATIONS INTEGRATION CENTER
PERMANENT MANNED PRESENCE
PLATFORM
PLATFORM SUPPORT CENTER
POLAR ORBIT PLATFORM
PRICING
PROXIMITY OPERATIONS
QUALIFICATION
REAL-TIME
REAL-TIME SUPPORT
REGIONAL OPERATIONS CENTER
S-BAND
SCENARIO
SERVICEABLE SATELLITE
SERVICING
SPACE (BASED) OPERATIONS
SPACE PLATFORM
SPACE STATION
SPACE STATION OPERATIONS
SPACE STATION PROCESSING FACILITY
SPACE STATION PROGRAM
SPACE STATION SUPPORT CENTER
SPACE SYSTEMS
SPACE TRANSPORTATION SYSTEM
STS CREW
STRATEGIC (OPERATIONS)
STRATEGIC (PLANNING)
STRATEGY
SUSTAINING ENGINEERING
TACTICAL (OPERATIONS)
TELESCIENCE
TRAFFIC MANAGEMENT ZONES
TRANSFER OPERATIONS
TRANSPARENT TECHNOLOGY
UNMANNED PLATFORMS
USER
USER OPERATIONS FACILITY
UTILIZATION
VALIDATION
VERIFICATION

## DEFINITIONS OF TERMS

**ACCOMMODATE**
To support in a general hardware, software, and personnel services context.
Note:

> Throughout the Space Station Program the term 'accommodate' should be used and interpreted as establishing the necessary hardware, software, and/or procedures for the associated relationship.

**AD-HOC**
For a specific purpose.

**ASSEMBLY**
Placing in orbit, arranging in flight configuration, and interconnection of the various elements and systems of the Space Station.

**ASTRONAUT**
One of a contingent of astronauts, each qualified to operate as a commander or crew member of a spacecraft, including the Space Station.

**ATTACHED PAYLOADS**
Payloads located on the Space Station structure outside the pressurized modules.

**AUTOMATION**
The operation or control of a process, equipment, or a system in a manner essentially independent of external influence or control; the condition of being automated.

**AUTONOMY**
Independence of a flight system from direct real-time control by the ground. The condition of being autonomous; self-governing community.

**CAPABILITY**
A functional attribute of any element of the Space Station Program.

**CAPACITY**
Quantity generally associated with an existing capability.

**CARGO**
Complement of equipment to be delivered to orbit by the Space Shuttle or an expendable launch vehicle; also an element of this overall complement.

**CENTRALIZED**
Having one source for management and control actions. Focusing specific capabilities in one strategic location. Organized in a manner so that there is a single source of authority for all command, control and direction of related functions.

**CERTIFICATION**
See VERIFICATION

**CHECKLIST**
A booklet or the equivalent data base file containing system operating procedures or integrated flight procedures in an abbreviated form to support various station, platform or payload activities.

**CHECKOUT**
Test activities that verify the readiness of hardware and/or software for its intended use.

**CO-ORBIT**
In the same, or nearly the same orbit as another object,particularly with respect to the orbit period. To orient so as to require very little final control velocity such as to execute a rendezvous, docking, berthing, or tending mission.
Notes:

> In the strictest sense, two co-orbiting objects would be coincident. In practice, and in any context associated with the Space Station Program, a co-orbiting object would have the same period, eccentricity, ascending node and argument of perigee; but would be at a slightly different right ascension (i.e., stable station-keeping ahead of, or behind the Space Station).

**CO-ORBITING PLATFORMS**
A Space Platform with the same average orbital period, inclination, and node as the Space Station, and maintaining its orbit path along that of the Space Station.

**COLUMBUS MODULE**
The laboratory module provided by ESA that is to be part of the baseline configuration of the Space Station.

**COMMAND AND CONTROL ZONE**
The traffic management zone within which the station crew serves as the primary control authority for all approaching and departing vehicles. A volume encompassed at 20 nautical miles above and below, 20 nautical miles fore and aft, and 5 nautical miles to port and starboard of the Manned Base.

**COMMONALITY**
The use of the same or similar vehicles, interfaces, modules, systems, or technical or operational approaches in two or more programs with the primary objective of improving operations effectiveness or reducing costs in one or more of the programs. Using components that are interchangeable between the manned base, the co-orbiting space platform, and the polar orbiting platform, and between elements of the manned base.

**CONCEPT**
An idea developed to the extent that stated objectives may be supported, that technical, economic and management approaches can be assessed, and that different concepts with the same, or similar objectives may be assessed for their relative merits.

**CONSUMABLES**
The materials that are expended during the course of meeting operational objectives.
Note:

> Unused consumables may be considered accountable and recoverable. Generally; "consumables" does not apply to the wear out of system components. See EXPENDABLES.

**COSTING**
The process of determining the amount of resources that have to be expended or exchanged to acquire possession of, and or disposition control over any particular item or object at large: often based upon market analysis and cost-estimating-relationships, or CER's.

**CREW**
A generic reference to all personnel on board the Space Station or the Space Shuttle.

**CREW MEMBER**
Any one member of the crew.

**CUSTOMER**
Anyone who uses the facilities and services provided by the Space Station Program, but is not directly responsible for station or platform systems development, operations, or maintenance. Also referred to as a user. See USER.

**DISCIPLINE OPERATIONS CENTER (DOC)**
A user supplied location providing support to a discipline user group oriented towards a specific area of investigation wherein users could share technical interests and common overhead costs. A specific type of user operations facility that coordinates operations amongst local discipline users, or with other proprietary user operations facilities in same discipline, during flight preparation and execution .
Note:

> Examples of user group disciplines include; materials sciences, life sciences, astro/solar/planetary physics, commercial production, etc.

**DISTRIBUTED SYSTEMS**
An intricate network of pipes, cables, conduits, tubes, wires, and other components, that carry electricity, air, water and other utilities and capabilities necessary for both station and platform operation and to allow the crew to survive and perform their roles and to serve the users needs.
Note:

> Major distributed systems include: the environmental control and life support; guidance, navigation and control; propulsion; power; data management; communications and tracking; structures and mechanisms; fluids; and thermal management.

**DOCKING**
The coupling of two or more spacecraft in space. The process of establishing a physical connection between two spacecraft during which an exchange of momentum is employed to operate the attachment mechanism(s).

**ENCLAVE**
With reference to an operations concept where each international partner independently operates their respectively contributed elements of the Space Station Program; autonomy of operation by each partner; separation of roles and responsibility by partnership. Foreign territory surrounded by another, specified country.

**ENGINEERING SUPPORT CENTER (ESC)**
The engineering support centers will provide on-call and real-time consultation and sustaining engineering support, and the repository for the technical characteristics for the flight and ground systems hardware, during the development phases and operational phases of the program.
Notes:

- Initially, ESC's will be located at the NASA and international partner's hardware development centers.
- As operations mature, sustaining engineering for the U.S. orbital elements would be centralized at the Kennedy Space Center.
- Sustaining engineering for the international partners orbital elements and all the program ground support systems and informations systems would remain distributed.

**EVOLUTION**
An addition of new elements, or new capability to any of the existing elements of the space station program or their systems, specifically after the development of the mature elements of the program. See also GROWTH.

**EXECUTION (OPERATIONS)**
Those activities that implement and operate the objectives described in the related strategy and tactics. Execution relates to the actual performance, enactment, or conduct of any operation -- in real-time. Generally, a reference to "now" with respect to time in the operating environment of the program. See STRATEGY.

**EXPENDABLE LAUNCH VEHICLE (ELV)**
A ground-launched propulsion vehicle, capable of placing a payload into Earth-orbit or Earth-escape trajectory, whose various stages are not designed for, nor intended for recovery or re-use.
Notes:

> The final stage(s) of an expendable vehicle may remain in orbit with the payload(s) unless they are provided with special de-orbiting systems.

**EXPENDABLES**
Items or materials that are used during the course of an operational activity. Expendable items, when issued, are dropped from the property accountability system and are considered unrecoverable. See CONSUMABLES

**EXPERIMENT**
That assembly of hardware, software, and operations, in space and on the ground that enables the user to meet the intended research objectives.
Note:
An experiment could include one or more payloads, delivered on one or more STS flights. Alternatively, one payload could encompass a number of individual experiments.

**EXTRAVEHICULAR ACTIVITY (EVA)**
Operations performed by crew members wearing space suits outside the habitable environment.

**FLIGHT**
The sequence of events that takes place between lift off and landing of STS Orbiter (or any aerospace vehicle). See MISSION.
Notes:
- The flight of a spacecraft such as the STS Orbiter is often divided into sub-parts (referred to as phases), e.g., powered flight, orbital flight (or on-orbit), reentry, approach, landing, etc.
- Because the operation of the Space Station is continuous, the term "flight" refers to on-board operations in space as well as those ground operations that are in direct support of the on-board operations.

**FLIGHT RULES**
Compilation of preplanned decisions designed to minimize the real-time analysis and decision process required when various situations occur. These decisions address both the existing on-orbit Space Station elements and those segments which are in transit to or from the Station.

**FRAMEWORK**
The recommended arrangement of selected concepts and options that demonstrates all the issues and principles considered by the Space Station Operations Task Force, and which meets all the cited objectives for the operations for the space station program.
Note:
The specific program objectives include: safe operations, fully supported user friendly operations and international participation, and due consideration of long term costs, evolutionary goals, and furthering science and technology development.

**GROUND (BASED) OPERATIONS**
Relating to activities or functions that are fundamentally formulated, planned, developed, controlled, executed, operated, and/or otherwise implemented on or from the ground. See SPACE BASED.

**GROWTH**
An increase in the capacity or capability of any of the existing elements of the Space Station Program or their systems; specifically after the development of the mature elements of the program. See also EVOLUTION.

**HEALTH MAINTENANCE FACILITY**
The in-flight facilities and equipment on-board the manned base capable of providing basic preventative, diagnostic, and therapeutic health care to the crew, commensurate with the level of on-board medical expertise.

**IN-SITU**
In the location where an object is situated. Particularly an object that is in space.

**INCREMENT (OPERATIONS)**
That period of time between STS missions to any of the Space Station Program Elements. For the manned base; from the launch of one Space Shuttle flight to the beginning of the next (ELV arrivals would be subsets within an increment). For platforms; from the launch (ground based or space based) of a space platform servicing mission to the beginning of the next. See TRANSFER (OPERATIONS), SPACE STATION OPERATIONS.
Notes:
- Each increment is initialized, and terminated, by the related transfer operations (launch to landing or return of the logistics or service mission).
- Increments are contiguous, e.g.; the transfer operations occur within the end, and beginning, of the related increment.
- Transfer operations may vary from a few days to weeks in duration.

**INFRASTRUCTURE**
All programs and projects with which the space station program must interface, and the processes and procedures by which the interfaces are operated and maintained.

**INITIAL OPERATIONAL CAPABILITY (IOC)**
A point in time in the contractual development of a project (e.g., the Space Station) at which the agreed upon, essential capabilities are operational for the first time.

**INTEGRATION**
The process of combining software elements, hardware elements, operations, networks, personnel, and procedures into an overall system or operation.

**INTERNATIONAL PARTNER**
Any of the non-U.S. partners participating and sharing in the design, development, and operation of the Space Station: National Research Council of Canada. National Space Development Agency (NASDA) -- Japan. European Space Agency (ESA)

**INTRAVEHICULAR ACTIVITIES (IVA)**
Operations performed by crew members within the habitable environment.

**INVESTIGATOR**
Principal investigator or the delegated alternative.

**JAPANESE EXPERIMENT MODULE (JEM)**
The Japanese-provided laboratory module that is part of the Station baseline configuration.

**KIWI**
Series of development studies by the Atomic Energy Commission with the goal of developing nuclear reactors useful in high-thrust rocket engines.

## DEFINITIONS OF TERMS
## (Continued)

**Ku BAND**
A band of frequencies in the radio frequency spectrum extending from 12.5 GHz to 18.0 GHz.

**LABORATORY**
A pressurized module designed to support specific types of payloads, e.g., a life science laboratory or a materials processing laboratory.

**LIFE CYCLE COST**
A process and technique for predicting and considering the entire cost of a program or project from inception through to ultimate disposition. The process is important to understanding long-term impacts of decision-making early in the lifetime of a program.

**LOGISTICS**
The management, engineering, and support activities required to provide personnel, materials, consumables and expendables to the space station elements reliably and in a cost-effective manner.
Notes:

- Logistics management responsibilities include the definition, allocation, scheduling, and control of equipment, personnel and process resources, and flow.
- Logistics engineering functions include equipment and process requirements definition, coordination, integration, and implementa-tion.
- Logistics support functions include provision-ing, storage, repair maintenance, and transportation of all station system parts, replacement units (ORU's), payload carriers and operational support personnel.
- The overall space station logistics network is referred to as the Integrated Logistics System (ILS).

**LOGISTICS OPERATIONS CENTER (LOC)**
Facilities and resources located at the launch site that manage, provide, and support all the required logistics operations and services for the station system.

**MAINTAIN**
To keep in existence or to keep in a certain condition. Specifically relating to the Space Station systems. See SERVICE/SERVICING.
Note:

- Maintain and maintenance relate specifically to the Space Station systems operations. Service and servicing relate to the users equipment and systems. Service is to the user as maintain is to the space station system.

**MAINTAINABILITY**
The ability of the space station systems to be maintained. The probability that an item can be restored to or retained with acceptable performance limits. See MAINTENANCE.

**MAINTENANCE**
The task of keeping things in existence or in a certain condition. The execution of all the necessary actions to retain or restore the space station systems within their specified performance limits. See MAINTAIN.
Notes:

- The frequency, magnitude and complexity of any maintenance, or the required level of maintenance, is described by the conditions to be met.
- To be maintained, an object must be maintainable or have the facility for maintainability; the level of maintainability must equal or exceed the required level of maintenance.

**MANIFESTING**
The process of defining what materials will be physically exchanged between the ground and space elements of the program, and when and how those transfers will be scheduled and implemented.

**MANNED BASE**
Major, manned element of the Space Station Program providing permanent manned presence in space. The manned base includes all the U.S and partner provided manned elements and all the related systems and structure.

**MATURE OPERATIONS PHASE**
The continuous period of activity commencing with the establishment of that configuration of the Space Station that provides a permanently manned capability in space, and continuing there after throughout the lifetime of the program. Mature operations will embody the management and operation of all subsequent growth and evolution.

**MISSION**
A mission generally refers to the sequence of events that must take place to accomplish some prescribed objective(s).
Notes:

- One or more mission can be accomplished in one flight of the Space Shuttle, or one mission can require two or more Space Shuttle flights.
- Any one shuttle flight can execute several concurrent missions, some in part and some in whole.
- The Space Station, including the space platforms, may implement and execute on-board activities as a series of missions (occurring serially or in parallel), each mission relating to a prescribed payload or on-orbit activity.

**MISSION SET**
The complement of payloads that is onboard the Manned Base or a Space Platform at any given time.

**MODULE**
Major elements of the Manned Base including: The Habitability Module, U.S. Laboratory Module, Japanese Experiment Module, and the Columbus Module.

**ORBITAL MANEUVERING VEHICLE (OMV)**
The unmanned propulsive stage used to ferry between the station or shuttle and a platform or free-flyer. It will be used either to bring the spacecraft to the Station or shuttle for servicing or to perform servicing in-situ via a smart front end.

**ORBITAL REPLACEABLE UNIT (ORU)**
The lowest level of component or subsystem hardware that can be removed and replaced on location under orbital conditions.

**PARTNER**
International partner. SEE INTERNATIONAL PARTNER.

**PAYLOAD**
An aggregate of instruments and software for performance of specific scientific or applications investigations, or for commercial production. A specific complement of instruments, space equipment, and support hardware carried into space to accomplish a mission or discrete activity in space.
Notes:
- Payloads may be internal to pressurized modules, attached to the station structure, attached to a platform, or they may be free-flyers.
- A payload may be designed to be re-used either by return to the Earth's surface for refurbishment and re-launch, or by applied in-space services.

**PAYLOAD OPERATIONS**
Those ground based and space based activities associated with the strategic, tactical, and execution of plans, preparations and procedures to deliver a payload to its destined location, exercise the payloads capabilities on location and, as required, return or deliver all or part
of that payload to its final destination.
Note:
- User payload operations are usually undertaken by the user, the users non-program agent, or assigned program personnel under a resource assignment/allocation/refurbishment basis. When undertaken by Program personnel, user payload operations are usually referred to as servicing operations, or service operations.
- Station, or system, payload operations are usually referred to as maintenance operations, or engineering operations.
- Station or system payload operations are usually undertaken by program personnel.

**PAYLOAD OPERATIONS INTEGRATION CENTER (POIC)**
The payload operations integration center is a station program supplied facility to integrate user payload operations activities into the manned base. Similar functions for platforms are embodied in a platform support center (PSC). The POIC provides the focal activity for the distributed user operations facilities to develop an integrated user operations execution plan on an increment-by-increment basis, and supports the real-time management of in-flight departures from those plans.

**PERMANENT MANNED PRESENCE**
That point in the development and operation of the Space Station Program where the configuration of the manned base is capable of supporting man's presence on a continuous basis with only the incremental presence of the Space Shuttle Orbiter.
Notes:
- The capability to provide permanent-manned-presence does not mandate continuous manning (or permanent manning) which is, nonetheless, an inherent capability within the provisions of a permanent manned capability.

**PLATFORM**
See Space Platform

**PLATFORM SUPPORT CENTER (PSC)**
Platform support centers combine system and user support functions to provide for operations management and sustaining engineering for the platforms. Operations management can extend to interfaces with other platform user operations centers and facilities, and can include the planning and controlling of platform payload operations (mission objectives, including remote telescience) and platform transfer operations (service objectives) -- except when the co-orbiting platform is within a zone controlled by the manned base.
Note:
- Two PSC's are considered in the recommended framework; one at GSFC for the U.S platforms (POP and COP), and one in Europe for the ESA platform (POP).

**POLAR ORBIT PLATFORM (POP)**
See SPACE PLATFORM

**PRICING**
The process of determining the charges to be levied upon the users for accommodating their experiments and for other services as rendered; based upon actual costs and cost sharing agreements amongst the U.S. and the international partners.

**PROXIMITY OPERATIONS**
Activities relating to mission and flight control operations that take place within the proximity (approximately 1 Km) of the space station.The operation of one or more spacecraft within the vicinity of another, with the relative positions stabilized and the rate small enough to preclude the requirement for re-rendezvous.

**QUALIFICATION**
See VERIFICATION

**REAL-TIME**
Defines a system response with the smallest, practical time delay taking computational processing, required communications, and associated I/O activities into account. Essentially; -- now.

**REAL-TIME SUPPORT**
Operational support functions which are provided (and executed) while a mission is in progress.

**REGIONAL OPERATIONS CENTER (ROC)**
A partner supplied, geographically focused location providing support to regionally based user groups wherein users could share common overhead costs or technical interests. An ROC includes facilities that can support user operations integration functions such as coordinating operations amongst local users, discipline centered users, or with other proprietary user operations facilities during flight preparation and execution.

**S-BAND**
A band of frequencies in the Radio Frequency spectrum from 1.55 GHz to 5.2 GHz

## DEFINITIONS OF TERMS
## (Continued)

**SCENARIO**
Hypothetical, structured example. An enactment or presentation of one possible set of events, often from amongst many other possibilities.

**SERVICEABLE SATELLITE**
A satellite designed to be provided with some degree of servicing in space to re-establish or sustain its mission capability.

**SERVICING**
To keep in existence or to keep in a certain condition. Specifically relating to the Users space equipment and systems. See MAINTAIN and MAINTENANCE.
Note:

Maintain and maintenance relate specifically to the Space Station systems operations. Service and servicing relate to the users equipment and systems. Service is to the user as maintain is to the space station system.

**SPACE (BASED) OPERATIONS**
Relating to activities or functions that are formulated, planned, developed, controlled, executed, operated, and/or otherwise implemented in space, particularly in association with the Space Station. See GROUND BASED.

**SPACE PLATFORM**
An unmanned, orbiting, multi-use structure, capable of supplying utilities to changeable payloads, dependent upon the Space Station or the Shuttle for its long-term operation.
Notes:

- The recommended framework assumes a baseline of three platforms for the initial Space Station Program: Two U.S. platforms; one (POP) in polar orbit and serviced from the NSTS, and one (COP) co-orbiting with and serviced from the Space Station; and one European platform in polar orbit.

**SPACE STATION**
The term **Space Station, Space Station Program**, and **Station** should be interpreted as global terms,each referring to all of the components of the program, both in space and on the ground. Components of the program include the **Manned Base**, the **Co-Orbiting Platform**, the **Polar Orbiting Platform**, the **Orbital Maneuvering Unit**, and the **ORUs**. See SPACE STATION PROGRAM, STATION.

**SPACE STATION OPERATIONS**
All program wide, space based and ground based activities required to operate the Space Station Program Elements.
Notes:

- Space Station Program activities are a series of mission increments for both the manned base and the space platforms, each increment including the plans for a series of on-orbit operations and payload execution.

**SPACE STATION PROCESSING FACILITY (SSPF)**
A facility in the vicinity of the STS launch operations that houses the prelaunch processing activity for all space station hardware destined to orbit, and all prelaunch and post flight logistics turn-around processing, including payload rack-to-station interface verification, checkout, and certification for flight.

**SPACE STATION PROGRAM**
The aggregation of U.S. and international partner space projects, space craft, space systems, and ground systems generally associated with the development and operation of, and encompasses within the interface specifications for, a permanent Manned Base, Space Platforms and an Orbit Maneuvering Vehicle, and whose development and operation and funding are managed by NASA and the international partners.

**SPACE STATION SUPPORT CENTER (SSSC)**
The SSSC provides centralized systems management and control for the manned base, including the elements provided by the partners, and has the safety responsibility for the crew and manned base. The SSSC also approves the integrated plan for user and systems activities based on the criteria for overall systems integrity, crew operations effectiveness, and crew safety. The SSSC monitors the systems status of the manned base, relays commands to support general systems operations and insures that safety requirements are met. Crew training facilities are closely associated with the SSSC.

**SPACE SYSTEMS**
Those Program-provided, distributed or element-unique orbiting systems whose safe and predictable operation is fundamental to the safety of the crew, the integrity of the manned base or platforms, for the effective utilization of manned base or platform resources.

**SPACE TRANSPORTATION SYSTEM (STS)**
The Space Shuttle fleet, and all the related ground based facilities and equipment.

**STS CREW**
Those personnel whose primary responsibility is the operation of the Orbiter. Does not include Station personnel in transit onboard the Orbiter as passengers.

**STRATEGIC (OPERATIONS)**
Those functions concerned primarily with establishing and coordinating policy and objectives. See STRATEGY

**STRATEGIC (PLANNING)**
That planning that leads to approval of a mission; that process required to define the combined plans for the platform/station/ payload, and transportation missions. See STRATEGY.

**STRATEGY**
The science of directing large scale program operations. Maneuvering into the most advantageous position prior to an engagement.
Notes:

- In general, strategy and tactics are associated with "planning" and "doing" and, as a set, can be applied to circumstances in many different time scales; similarly structured sets of strategy and tactics can be "nested" (in the computer software sense) so that accomplishment of any major objective can involve a hierarchy of strategy and tactics.
- The terms execution and engagement are often used to relate to specific accomplishment and achievement within the framework of tactics.
- In the military context; strategy (plans and planning) precedes tactics; tactics (the enemy is in sight) precedes engagement: engagement implements action.

- The OTF has applied "strategy" and "tactics" in fairly specific connotations: strategy (more than one to two years before the event) precedes tactics; tactics (up to two years before the events, down to the event itself) precedes execution; execution implements the event).

**SUSTAINING ENGINEERING**
Sustaining engineering is performed at the Engineering Support Centers at the launch site and/or the development center. The engineering encompasses analytical and technical services as well as management and training services and operations. The Space Station operations framework recognizes three general types of sustaining engineering: flight systems maintenance engineering performed at the launch site and development center and development centers on space systems and ORU hardware; flight systems design engineering performed at the development centers on assigned space systems and; payload integration engineering performed at the launch site or development site on program approved payloads.

**TACTICAL (OPERATIONS)**
Those functions concerned primarily with using the established strategy, policy, and objectives to produce plans and direction for their accomplishment. See STRATEGY.

**TELESCIENCE**
A mode of space based scientific investigation, including operations and analysis, that is executed remotely from the principle location of the associated equipment. Ground-based users may interact directly with real-time command and control operation of the space-based equipment in response to real-time observed data.
Note:

- Depending upon the degree of sophistica-tion, telescience operations may be enhanced by incorporating telepresence as one of many features of advanced teleoperations.
- Teleoperations encompasses any remotely managed activity, with or without feedback of operations data to allow a local operator to interact with the remote activity.
- Telepresence is a level of sophistication in teleoperations where the operator receives sufficient sensory information from the remote location (mono/stereo video, audio, tactile, etc.) to be able to create a high resolution image of the remote location within which the local operator can experience a physical sense of presence at the location of the investigation.

**TRAFFIC MANAGEMENT ZONES**
Specified regions around the Space Station that define the operational boundaries for proximity operations, station command and control, departure, rendezvous, co-orbiting satellites, non-co-orbiting satellites, and parking orbits, etc.

**TRANSFER OPERATIONS**
A period of time during which the manned base is involved with the arrival and departure of an STS enabled logistics type mission, or the platforms are involved with an OMV enabled logistics type mission, each providing equipment transfer and installation.
Notes:

- The manned base transfer operations period extends from prior to STS arrival (while equipment is being prepared for return to earth), to sometime after STS departure (while equipment is being installed).

**TRANSPARENT TECHNOLOGY**
A system component is said to represent 'transparent' technology if the component can be replaced by a component based on a different technology without affecting the rest of the system.

**UNMANNED PLATFORMS**
See SPACE PLATFORMS.

**USER**
Any organization, group, or individual who uses or plans to use the Space Station or any other Space Station Program Element as the vehicle for the operation of a payload or related mission. See CUSTOMER.

**USER OPERATIONS FACILITY (UOF)**
User operations facilities are built and operated by the user as best suit the needs associated with the payload operations and the experiment objectives. The facilities can be equipped to support personnel and equipment involved in payload operations, to monitor and control experiments, transmit payload commands, and storing and analyzing data products from the station.
Note:

- User operations facilities may operate as independent interfaces to the program, through the payload operations integration center (POIC), or they may be affiliated with discipline operations centers (DOC's) or the regional operations centers (ROC's).

**UTILIZATION**
A broad program aspect of the Space Station Program associated with the beneficial use and utility of the Space Station Program Elements.
Notes:

- Utilization encompasses the process of identifying Space Station users and customers, defining, and refining their requirements for space services and capabilities, integrating these requirements into the Space Station Program as interface hardware, software, and procedures.
- Utilization encompasses this role for the initial Space Station and throughout the evolutionary growth.

**VALIDATION**
See VERIFICATION

**VERIFICATION**
The process of proving circumstances to be true or of being well grounded.
Notes:

- "Certification", "Qualification", "Validation", and "Verification" are used extensively in the OTF documentation.

## DEFINITIONS OF TERMS
## (Continued)

- In general, certification and qualification tend to deal with qualities: CERTIFICATION emphasizes properties that are attributable to a product or person; QUALIFICATION tends to emphasize the requirements that a product or person must have to meet an application.

- In general, validation, and verification deal with assurance and confidence in assertion, they tend to endorse the accuracy and truth in the certification and qualification process: VALIDATION tends towards repeated assertion that conditions of truth are evident; VERIFICATION tends towards proving or reproving a fact to be true, such as testing to demonstrate capability.

# APPENDIX E

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